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THE NAIAD-FAUNA OF THE TENNESSEE RIVER SYSTEM BELOW WALDEN GORGE

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The present paper is a contribution to a general study of the "Cumberlandian" Naiad-fauna, which has for its final object the reconstruction of the ancient drainage features of the southern Appalachians and the Cumberland Plateau. It is a sequence to several previous publications (Ortmann, '18, '23-'24, '24).

In the paper of '24, I have tried to define the term "Cumberlandian" Naiad-fauna, and in the present paper it will be my chief aim to point out those forms which belong to this fauna in the drainage of the *lower Tennesee, below the Walden Gorge at Chattanooga.* As will be seen, there is, in this region, a mixture of Cumberlandian elements with others, which belong to the "Interior Basin," and have their center of dispersal in the lower Ohio and its vicinity.

The necessity of such a study, and of a synopsis of the Naiad-fauna of the lower Tennessee, becomes very obvious, when we consider that the most famous and unique locality in these parts, the "Mussel-Shoals," is now on the best way to be utterly destroyed by the construction of the "Wilson dam" (see: Science, Dec. 19, '24, pp. 565, 566). No complete list of the shells of this region has ever been published, although a number of scattered and fragmentary notes is on hand. The Tennessee River *below* the Mussel-Shoals was hitherto unknown.

The Carnegie Museum possesses a large amount of unpublished material from this region, obtained in various ways, which gives a rather full representation of this fauna,

so that only in very few cases I have to rely exclusively upon other authorities. In a number of cases, I also have the advantage of having examined the collection of B. Walker in Detroit, which contains a wealth of valuable material, and I am under great obligations to Mr. Walker for the privilege of using the information thus obtained in the present paper.

The following list of localities will give an idea of the character of the material at hand.

LIST OF LOCALITIES.

Tennessee River, Trotters Landing, Dixie, Humphreys Co., Tenn.

Material in Car. Mus. collected by the writer, Aug. 20, '24. This is the only known locality for Naiades *below* the Mussel Shoals.

The river at this place is large, in mature stage, flowing steadily over a gravel-bottom in the main channel. The banks are largely muddy. Most of the shells were obtained from the piles of clam-diggers.

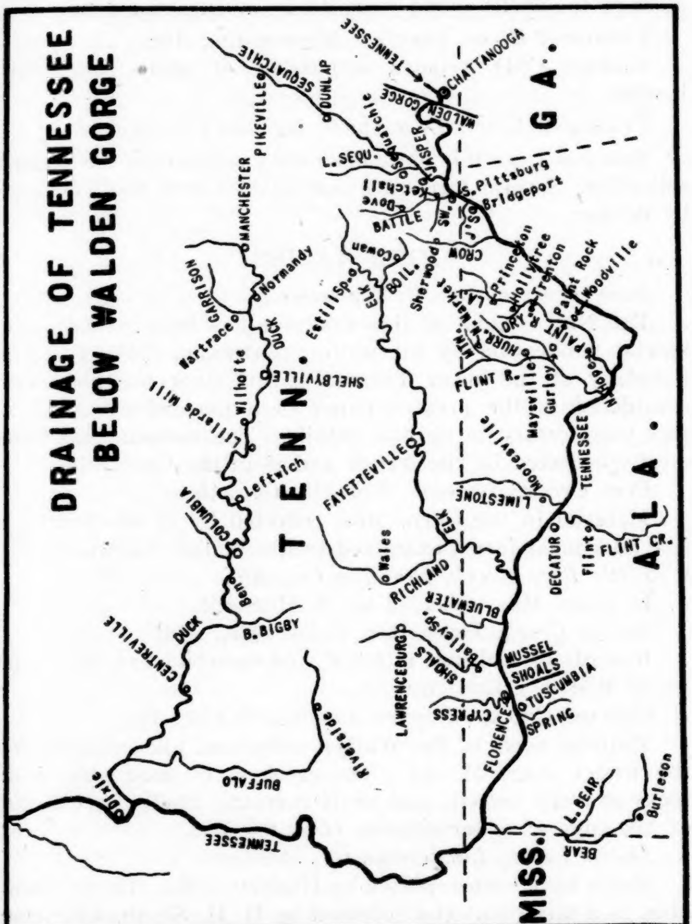
Tennessee River, Tuscumbia, Colbert Co., and *Florence, Lauderdale Co., Ala.*

These are the "Mussel-Shoals," lying mostly several miles above Florence, but they practically form one and the same locality, with the same ecological conditions.

Older records from these parts have been furnished by Conrad, Lea, and Call. More recently ('06), Hinkley has published a list of forms collected by himself in the fall of 1904. The Carn. Mus. has material from various sources, obtained by donation or purchase from the collections of W. D. Hartman, H. H. Smith, V. Sterki, and B. Walker, but mostly collected by H. H. Smith (1904-1910), and donated by G. H. Clapp.*)

Finally, the present writer has collected here on Aug. 26, 1924, between the Florence bridge and Wilson Dam. At this

* The collections made by H. H. Smith in Alabama and surrounding parts have been divided between the University of Alabama, Mr. B. Walker, and Mr. Geo. H. Clapp. Mr. Clapp has turned over his share to the Carnegie Museum, for which generous gift the Museum is greatly obliged to him.


DRAINAGE OF TENNESSEE
BELOW WALDEN GORGE
TENNESSEE
CHATTANOOGA
WALDEN GORGE
SEQUATCHIE
PIKEVILLE
DUNLAP
L. SEQU.
Sequatchie
JASPER
Ketchall
Dove
BATTLE
SW.
S. Pittsburg
Bridgeport
J's
G A.
MANCHESTER
GARRISON
Normandy
Cowan
BOIL.
Sherwood
CROW
Princeton
Hollytree
Trenton
Paint Rock
Woodville
Estill Sp.
ELK
LA.
MTN.
N. Marker
DRY
HURR.
PAINT R.
Hope
Wartrace
DUCK
SHELBYVILLE
FLINT R.
Maysville
Gurley
Lillards Mill
Wilholte
Mooresville
TENNESSEE
Leftwich
FAYETTEVILLE
LIMESTONE
T E N N.
COLUMBIA
Wales
ELK
DECATUR
Flint
FLINT CR.
A L A.
Bend
RICHLAND
BLUEWATER
DUCK
B. BIGBY
CENTREVILLE
Baileys Sp.
SHOALS
LAWRENCEBURG
MUSSEL SHOALS
TUSCUMBIA
CYPRESS
FLORENCE
SPRING
Riverside
BUFFALO
Dixie
L. BEAR
Burleson
TENNESSEE
BEAR
MISS.

place the river has a good current over rocks and gravel, but on the banks there is a good deal of mud in quiet eddies. Most of the shells found were dead (muskrat-material.)

Tennessee River, Decatur, Morgan Co., Ala.

Hinkley ('04) reports a number of shells from this locality.

Tennessee River, Bridgeport, Jackson Co., Ala.

Material from this place has been examined in the Walker collection. Several forms are also in the Carn. Mus., donated by Walker.

TRIBUTARIES

Duck River system in Tennessee.

The Naiad-fauna of this drainage has been treated in a special publication by the writer (Ortmann, '24). Being a tributary of the lower Tennessee, this river has also been considered in the present paper in a general way, but it was unnecessary to go into details. The material has been mostly collected by the writer and is in the Carn. Mus.

Bear Creek, Burleson, Franklin Co., Ala.

Material in the Carn. Mus. collected by H. H. Smith; a few additional forms examined in the Walker collection.

Little Bear Creek, Franklin Co., Ala.

In Carn. Mus. collected by H. H. Smith.

Spring Creek, Tuscumbia, Colbert Co., Ala.

Records by Call are at hand, and material has been seen in the Walker collection.

Cypress Creek, Florence, Lauderdale Co., Ala.

Material seen in the Walker collection, and collected by the writer Aug. 24, '24. The creek is of good size, with rocky-gravelly bottom, and swift current. Shells were found on the edge of water-willows (*Dianthera.*)

Shoals Creek, Lauderdale Co., Ala.

Shells have been reported by Hinkley ('06). In the Carn. Mus. is a large material collected by H. H. Smith, and some donated by Walker.

No exact locality is given, but probably the lower part of the creek is meant.

Shoals Creek, Bailey Springs, Lauderdale Co., Ala.

Material in Carn. Mus. collected by the writer Aug. 25, 1924.

Shells in rocky riffles, chiefly at the upper end; some along the edge of waterwillows.

Shoals Creek, Lawrenceburg, Lawrence Co., Tenn.

In Carn. Mus., collected by the writer, Sept. 1, 1923.

Among water willows, in riffles.

Bluewater Creek, Lauderdale Co., Ala.

Material in Carn. Mus. collected by H. H. Smith; some additional forms seen in Walker collection.

Lower Elk River, Limestone Co., Ala.

Records given by Conrad and Call are used, as well as material seen in the Walker collection.

This is in the lower part, near the mouth of Elk River, but without exact locality.

Elk River, Fayetteville, Lincoln Co., Tenn.

Mostly in Carn. Mus. collected by H. H. Smith, but also in Walker collection, from the same source.

Elk River, Estill Springs, Franklin Co., Tenn.

In Carn. Mus., collected by H. H. Smith.

Richland Creek, Wales, Giles Co., Tenn. (*to Elk R.*)

In Carn. Mus., collected by the writer Aug. 31, '23.

In riffle along a gravel bar.

Boiling Fork, Cowan, Franklin Co., Tenn. (*to Elk R.*)

In Carn. Mus., collected by H. H. Smith.

Flint Creek, Morgan Co., Ala.

Reported by Conrad without exact locality, but probably above the next locality. This is the Flint *River* of Conrad, different from Flint River in Madison Co., see below.

Flint Creek, Flint, Morgan Co., Ala.

In Carn. Mus., collected by the writer Aug. 28, '24.

The creek is sluggish here, and, although flowing between banks partially composed of massive limestone rocks, has sandy-muddy bottom, with a corresponding fauna.

Limestone Creek, Mooresville, Limestone Co., Ala.

Material examined in Walker collection.

Flint River, Gurley, Madison Co., Ala.

Mostly in Carn. Mus., collected by H. H. Smith; some in Walker collection from the same source.

Flint River, Maysville, Madison Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Hurricane Creek, Gurley, Madison Co., Ala., (to Flint R.)
In Carn. Mus., collected in part by H. H. Smith, in part by H. E. Wheeler, Sept. 13, '10; a few additional forms in Walker collection.

Mountain Fork, New Market, Madison Co., Ala. (to Flint R.)
In Carn. Mus., collected by H. E. Wheeler, August '10.

Paint Rock River, New Hope, Madison Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Woodville, Jackson Co., Ala.
Reported by Simpson ('14).

Paint Rock River, Paint Rock, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith; also in Walker collection.

Paint Rock River, Trenton, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Holly Tree, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Princeton, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith; also some material in Walker collection.

Dry Fork, Holly Tree, Jackson Co., Ala. (to Paint Rock River.)
Material examined in Walker collection.

Larkins Fork, Princeton, Jackson Co., Ala., (to Paint Rock R.)
In Carn. Mus., collected by H. H. Smith.

Crow Creek, Sherwood, Franklin Co., Tenn.
In Carn. Mus., collected by H. H. Smith.

Jones Creek, Bridgeport, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Battle Creek, South Pittsburgh, Marion Co., Tenn.
In Carn. Mus., collected by H. H. Smith.

Battle Creek, Dove, Marion Co., Tenn.
In Carn. Mus. and Walker collection, collected by H. H. Smith.

Sweden Creek, Ketchall, Marion Co., Tenn. (*to Battle Creek.*)

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Sequatchie River, Jasper, Marion Co., Tenn.

In Carn. Mus., collected by C. Goodrich, Sept. '23; also in Walker collection, collected by Wetherby.

Sequatchie River, Dunlap, Sequatchie Co., Tenn.

In Walker collection, collected by C. C. Adams, and in Carn. Mus. collected by C. Goodrich, Sept. '23.

Sequatchie River, Pikeville, Bledsoe Co., Tenn.

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Stream flowing from spring (*to Sequatchie*), *Jasper, Marion Co., Tenn.*

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Little Sequatchie River, Sequatchie, Marion Co., Tenn.

In Carn. Mus. collected by C. Goodrich, Sept. '23.

In the following enumeration the above localities are given in an abridged form, easily understood. MS stands for Mussel-Shoals. I have marked records supported by material in the Carnegie Museum by an exclamation mark (!), and such records, which I secured or confirmed by my own collecting by a double exclamation mark (!!). Forms belonging to the "Cumberlandian Fauna" (Ortmann, '24 pp. 40-44) are marked with an asterisk (*).

ENUMERATION OF SPECIES AND VARIETIES, WITH REMARKS ON TAXONOMY AND DISTRIBUTION.

1. *Cumberlandia monodonta* (*Say*).—Ms (!!)—Sequatchie R., Jasper (!)

According to the considerable number of dead shells seen by myself at the Mussel-Shoals, this species must be, or have been, abundant at this place. Goodrich collected a single individual at Jasper. For the rest, it is not known from any other place in the lower Tennessee region.

This species seems to be most abundant in the Cumberland and Tennessee drainages, including the upper Tennessee. But it is also present in the lower Ohio, the lower Wabash, the Mississippi above Cairo, and the lower Illinois River. It

is also known from Osage River in Missouri (Utterback), and from Ouachita River in Arkansas (Wheeler). These latter localities are rather isolated, and seem to belong to different parts of the Ozark region. It is quite possible, that they indicate the former connection of the Ozarks with the Cumberland Plateau, before the Upper cretaceous Mississippi Embayment was formed. There are several other cases parallel to this.

2. *Fusconaia ebenus* (*Lea*).—Dixie (!!)—MS(!)—Decatur (Hinkley).

Found to be rather numerous at the first place; from the Mussel-Shoals I have only one specimen, rather typical, but small, collected by Smith. Hinkley mentions it from the same place and from Decatur. It is entirely absent from the upper Tennessee system (above Walden Gorge),* but is abundant in the lower Cumberland, going up to Wayne Co., Ky. It is common in the larger rivers of the Interior Basin, with a considerable extension of the range southward.

Thus it seems to belong to the latter region, and is a modern immigrant both in the Cumberland and Tennessee rivers.

3. *Fusconaia subtrotunda* (*Lea*).—Dixie (!!)—MS(!)—Bridgeport (Walker coll.)

This is known only from the main river. The specimens at hand have the dimaeter from 51 to 66 percent of the length, and thus represent the typical *subrotunda*. One from Dixie has a length of 70 mm, and one from the Mussel-Shoals that of 88 mm. Thus they equal, and even considerably surpass the maximum size of *F. pilaris* of the upper Tennessee (Ortmann, '20 p. 309). I have repeatedly pointed out (Ortmann, '18 p. 527 and '20 p. 278), that the only difference of *pilaris* from *subrotunda* is the smaller size of the former. Thus it is absolutely impossible to distinguish younger *subrotunda* from *pilaris*, and we should unite both into *one* species. This requires a straightening out of the nomenclature of the headwaters-races of both, *subrotunda*

* It has been mentioned as from Holston and French Broad Rivers by Boepple and Coker ('12), but this surely rests on a misidentification of some form of the *F. pilaris* group of that region.

(*kirtlandiana*) and *pilaris* (*lesueuriana* and *bursa-pastoris.*) But this is simply a question of convenience and priority.

Thus *F. subrotunda* is found in the upper and lower Tennessee; it is in the Cumberland, and very abundant in the Ohio system. Its center of origin is obscure.

(*) 4. *Fusconaia cuneolus* (*Lea.*)—Bear Cr., Burleson (!)—Limestone Cr. Mooresville (Walker coll.)—Flint R. Maysville (!)—Hurricane Cr., Gurley (Walker coll.)—Paint Rock R., Paint Rock (!).

Found only in some of the tributaries of the lower Tennessee, but possibly overlooked in others. A small creek form, passing in the downstream direction into the more swollen *F. cuneolus appressa.* Specimens from Bear Cr., Limestone Cr., Hurricane Cr., and Paint Rock R. stand very close to the latter (dia. 48 and 49 percent of length), and have been found associated with it in Bear Cr., Limestone Cr., and Paint Rock R. Specimens from Maysville have the dia. of 43 and 45 percent, and thus are more typical *cuneolus.*

A Cumberlandian form, but restricted to the upper and lower Tennessee. Shells of this type are missing in Duck River, as well as in the whole Cumberland drainage.

(*) *Fusconaia cuneolus appressa* (*Lea*).—MS (Lea)—Bear Cr., Burleson (Walker coll.)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

The Mussel-Shoals (Tuscumbia; also "Tennessee and Holston Rivers") are the type-locality of this form, but I have seen no material from this place, unless the figured type of Lea, which I have seen in Washington, is from Tuscumbia, (concerning this type, see Ortmann, '18 p. 531). The diameter of this specimen is 52 per cent of the length. The synonym *U. tuscumbiensis Lea,* also from the Mussel-Shoals, has a diameter of 56 to 58 per cent (Ortmann, '20 p. 284). A specimen collected by myself in Flint Creek has the diameter of 57 per cent, and others from Paint Rock have 50 and 57 per cent. In the Walker collection are specimens from Mooresville with the diameter up to 63 per cent. All these thus represent this variety, which belongs to the larger rivers, also in the upper Tennessee drainage (Ortmann, '20

p. 284 ff). The fact that the specimen from Flint Creek was found in a small creek, but in smooth, sandy-muddy bottom, possibly indicates that not so much size of stream, as character of bottom and current determine the development of the "big -river-type."

The general distribution of *F. cuneolus appressa* is the same as that of *F. cuneolus,* with the exception that it prefers larger streams. It is also a Cumberlandian type, missing in Cumberland and Duck Rivers.

(*) 6. *Fuscnoaia edgariana (Lea).*—MS (Lea) (Hinkley)—Cypress Cr. Florence (Walker coll.)—Flint R., Gurley (Walker coll.)—Paint Rock R., Paint Rock (!)—Trenton (!).

The Mussel-Shoals are one of the type-localities of this form, but I have seen no specimens from them. It is also in the lower parts of the tributaries, which is most evident in Paint Rock River, where the large-river-form passes farther up into the small-river-type: *F. edgariana analoga* (see: Ortmann, '20 p. 287). A specimen from Cypress Creek (lower part) in the Walker collection has the diameter of 54 per cent, another one from Gurley has 52 per cent.

The general distribution of this Cumberlandian type is very similar to that of *F. cuneolus.* It is found in the upper and lower Tennessee, but is missing in Cumberland and Duck Rivers. The present form belongs to the larger rivers.

(*) 7. *Fusconala edgariana analoga* (Ortmann).—Paint Rock (!)—Trenton (!)—Princeton (!).

Known only from Paint Rock River. It has here the same relation to the main species as in the upper Tennessee (Ortmann, l. c.) It deserves mention that the *edgariana*-group has not been found in Bear Creek, Shoals Creek, and Elk River, but it is impossible to decide, whether it is positively missing, or has been only overlooked.

A Cumberlandian type, with the same general distributional features as the main species, but restricted to the headwaters.

(*Unio cor Conrad* has been described from "Elk and Flint Rivers" (Flint Creek). For a time it was believed by Frierson and Ortmann ('18 p. 532), that this is the same as *F. edgariana* (or a related form.) However, Ortmann and Walker ('22 p. 6), following Pilsbry, have kept it separated, as *F. cor.* If this is correct, *U. cor* has never

been found subsequently to its first description, and must be regarded as an unidentified or spurious species.) (See Note at the end of this paper, p. 371).

(*) 8. *Fusconaia barnesiana* (*Lea.*)—MS (Lea)—Middle Duck R. and tributaries (!!)—Bear Cr., Burleson (Walker coll.)—Spring Cr., Tuscumbia (Call) (Walker coll.)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Fayetteville (!)—Estill Springs (!)—Richland Cr., Wales (!!)—Limestone Cr., Mooresville (Walker coll)—Sequatchie R., Dunlap (Walker coll.)

Generally the form of rivers of medium size, but reported by Lea (as *meredithi* and *pudicus*) from the main river at the Mussel-Shoals. It is found in almost all tributaries: probably it is present everywhere under the proper conditions.

A Cumberlandian type, very characteristic on account of its frequency and its very general distribution in the Cumberland, lower and upper Tennessee, but absolutely missing outside the region. Yet there are two related, but perfectly distinct species, one in southern Alabama and West Florida (*F. succissa* (*Lea*), see: Ortmann, '23, p. 73), the other in the Ozark region (*F. ozarkensis* (*Call*), see Ortmann, Naut. 31. '17 p. 62). The latter tends to demonstrate the former connection of the Ozarks with the Cumberland Plateau. From the headwaters of the Alabama system, the *barnesiana*-group is not yet known.

(*) 9. *Fusconaia barnesiana tumescens* (*Lea*).—MS (!!)

Call was the first to report this form from the Tennessee River in North Alabama, and Hinkley has it from the Mussel-Shoals. I found a number of specimens myself, several of them living, and there is a great material at hand collected by Smith.

Not known from any other place in the lower Tennessee region; but it is present in the larger rivers of the upper Tennessee drainage (Ortmann, '20 p. 288). From the Cumberland it has been reported under the synonym: *Pleurobema crudum* (*Lea*) (see: Wilson & Clark). From Duck River this large-river form is not known, although the other two

forms of the group are abundant. Thus it is a Cumberlandian type.

(*) 10. *Fusconaia barnesiana bigbyensis* (*Lea*).—Headwaters of Duck R. (!!)—Bear Cr., Burleson (Walker coll.)—Spring Cr., Tuscumbia (Walker coll.)—Shoals Cr., Bailey Springs (!!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Paint Rock R., Princeton (!).

The type locality is in Big Bigby Creek of the Duck River drainage. As the small-creek-form of this group it is absent in the main river, but present, toward the headwaters, in several of the tributaries, and probably more generally distributed than the above records indicate. At several places it has been found to intergrade with the typical *barnesiana*. In a large set collected by Smith in Shoals Creek, without exact locality, all three forms of *barnesiana* are represented. In Elk R., Richland Cr., and Paint Rock R., this form also attains the large size known from elsewhere.

Also Cumberlandian, and apparently abundant in small streams of both, the lower and upper Tennessee drainage, but not yet known from the Cumberland system, where the other two forms seem to be present.

11. *Megalonaias gigantea* (*Barnes*).—Dixie (!!)—MS (!!)—Lower Duck R. (!!).

At Dixie, this species is very abundant, judging from the numbers found in the piles of the clam-diggers. At the other places it is scarce. It has been reported from the Mussel-Shoals by Hinkley. It is absent in the upper Tennessee.

A species of the Interior Basin, advancing into the Cumberland (up to Wayne Co., Ky.) and into the lower Tennessee and Duck rivers.

12. *Amblema costata Rafinesque*.—Dixie (!!)—MS (!!) Duck R., common (!!)—Bear Cr., Burleson (!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Sequatchie R., Jasper (!)—Dunlap (!).

Abundant in our region, in larger and smaller rivers, but decidedly rare at Dixie: very few specimens were seen

at this place in the piles of the clam-diggers, mixed in with the abundant *Megalonaias gigantea.*

I call all specimens at hand by this name, although, according to the definition given by Ball ('22 p. 104), some of my material would fall under *A. peruviana* (*Lam.*). Ball gives for the typical *costata* the maximum obesity of 47 per cent of length. Specimens from the upper Duck, Bear Cr., Elk R., upper Paint Rock R., and Sequatchie R. are entirely normal. In the lower Duck and at the Mussel Shoals, they incline to be slightly more swollen, indicating thus the influence of the large-river conditions. Yet, as already Ball (p. 106) has mentioned, shells of his *peruviana*-type (according to obesity) are found in Flint River and Hurricane Creek, and also in Paint Rock River. I have subsequently discovered a similar type in Flint Creek. In the latter case, the "smooth" bottom (sand and mud) seems to be the determining factor. But none of these shells with the obesity of Ball's *peruviana* has the swollen, inflated beaks of the true *peruviana*, and thus I prefer to call all my shells by the name of *costata*: it would be rather unnatural, to separate these individuals with a diameter of over 47 per cent as a different form, since they stand very close to the others, and are generally found associated with them. A higher percentage of diameter should better be made the separating line between the two forms, a percentage where the beaks are usually more prominent.

The single specimen at hand from Dixie is a typical *costata*, with the rather low diameter of 40 per cent.

This form is of wide distribution, in the Interior Basin as well as in Cumberland, lower and upper Tennessee. It is impossible to say where it has its center of origin.

13. *Quadrula pustulosa* (*Lea*).—Dixie (!!)—MS (!!)—Bridgeport (Walker coll.)—Lower and middle Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Paint Rock R., Paint Rock (!).

In the main river rather common; also in the lower parts of some of the tributaries. At Burleson, however, it is rather far up, in Bear Creek; in Shoals Creek probably in the lower part only.

This agrees with what is known elsewhere concerning the ecological preferences of this species. It is of wide distribution, being found in the interior Basin, in Cumberland, lower and upper Tennessee. We cannot tell anything about its center of origin.

14. *Quadrula quadrula* (*Rafinesque*).—Lower Duck R., Centreville (!!)—Flint Cr., Flint (!!).

The typical form of this species has been found only at two localities in the Tennessee drainage. It differs from the next form (*fragosa*) in the somewhat more elongated outline, in the greater compression, and in color, which is lighter with green markings, at least in the young shell. It differs also in the weaker development of the sculpture, although this character is not reliable. The best character seems to be obesity, and generally typical *quadrula* has a diameter of the shell of less than 50 per cent of the length. However, since the measurements of an authentic specimen of Rafinesque's *quadrula*, given by Vanatta, show the diameter of 52 per cent, I have decided to select this figure as the upper limit of this form.

Taking the species in this sense, all specimens at hand from the above localities belong here, with the dia. of 47-51 per cent at Centreville (4 specimens), and of 45-51 per cent at Flint (5 specimens). In both cases, the shells were found in mud, and possess the characteristic color of this form, except the largest from Flint, which is brownish, The shape is characterized by the proportional height of the shell (to length), and is 79-83 per cent in Duck R., and 81-85 per cent at Flint, partly overlapping with *fragosa*, which goes in the Tennesee drainage from 83-92 per cent. The tubercles are very variable, but generally less strongly developed than in *fragosa*. Thus the two forms closely inosculate, and should be regarded as varieties of the same species.

Qu. quadrula is abundant in the interior Basin, chiefly in the larger rivers, and seems to prefer more or less muddy bottom and quiet water. It has not been reported from Cumberland River, although *fragosa* is known from it. In the Tennessee, it apparently enters the lower part, goes into the lower Duck, and even beyond the Mussel-Shoals, but ap-

pears in its true form only under favorable conditions, such as are present in the lower part of Flint Creek. In other parts it is represented by the next form. It is absolutely missing in the Tennessee above the Gorge, and thus an immigrant from downstream.

15. *Quadrula quadrula fragosa* (*Conrad*).—Dixie (!!)—MS (!)—Middle Duck R. (!!).

Specimens from Duck River (Columbia, Lillards Mill, Wilhoite; Ortmann, '24 p. 16) and from Dixie are rather typical, with the H. 89-92 per cent of length, and the Dia. 54-62 per cent in Duck, and H. 93-98 per cent and Dia. 53-58 per cent at Dixie. They all have the epidermis of brown color, and the tubercles are generally strongly developed. Specimens from the Mussel-Shoals (4 specimens collected by Smith) have the H. 84-90 per cent, the Dia. 53-58 per cent, and thus are *fragosa*. But in color and development of tubercles they are more like typical *Q. quadrula*, possessing greenish markings (most distinctly the younger ones). The tubercles are not very strongly developed.

This form seems to be closely associated in its distribution with the typical *quadrula*, and is also missing in the Upper Tennessee, but present in the Cumberland. The conditions under which it turns up are not very clear yet. According to my experience (in Duck R.), it prefers gravel bars, while the typical *quadrula* is a mud-lover. From the Tennessee at Dixie I obtained them from clam-diggers' piles, and they probably came, with the rest of the shells, from the gravelly bottom of the main channel. But if this is the case, this form would be remarkable for the fact, that gravel-bottom develops a more swollen, strongly sculptured form, while mud-bottom has a less swollen and less sculptured form. This is—according to the present state of our knowledge—just the opposite of what we see in certain other species. This matter, however, requires further elucidation.

16. *Quadrula verrucosa* (*Rafinesque.*)—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., common (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Hurricane Cr., Gurley

(!)—Paint Rock R., Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

Abundant in the whole lower Tennessee drainage, in the main river as well as in most tributaries. Also abundant in the Cumberland and the whole Interior Basin, extending well southward and westward. In the Upper Tennessee it is only in Hiwassee River, but positively missing in the rest of this vast region (Ortmann, '18 p. 540). Thus evidently not a Cumberlandian type, but an immigrant from the Interior Basin, both in the lower Tennessee and the Cumberland. In the Cumberland it goes way up in the headwaters of the South Fork: I found it (Aug. 30, '24) in New River, at New River, Scott Co., Tenn.

17. *Quadrula metanevra* (*Rafinesque.*)—Dixie (!!)—MS (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Fairly abundant in the Tennessee proper, and also found in the lower parts of Limestone Cr. and Paint Rock R.; absent in Duck R. and the other tributaries. It goes in the upper Tennessee as far as Knoxville, but is rare there (Ortmann, '18, p. 541). It is present, but rare in the Cumberland (Wilson & Clark, '14 p. 59).

Widely distributed in the Interior drainage, extending southward to the Gulf Coastal Plain. Probably not indigenous in the Cumberland region, but an immigrant from the Ohio.

(*) 18. *Quadrula intermedia* (*Conrad*). — MS (Call) (Hinkley) — Bridgeport (Walker coll.)—Duck R., Columbia (!!).

These three localities are the only ones known for the lower Tennessee. The typical *intermedia* is found in Duck R., while what I have seen from Bridgeport is rather the form called *tuberosa Lea,* which probably is only a more swollen form of *intermedia* (Ortmann, '18 p. 541). This same form (*tuberosa*) is also given for the upper Cumberland (Wilson & Clark, '14 p. 59). In the upper Tennessee it is chiefly in the smaller streams, and in its typical form.

A Cumberlandian type, entirely missing in the Interior Basin.

19. *Quadrula cylindrica* (*Say*).—MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

In the main river and some of its larger tributaries, but not yet known from Elk and Flint Rivers. Widely distributed in the Interior Basin, in Cumberland and upper Tennessee. Thus we cannot locate its center of origin.

20. *Cyclonaias tuberculata* (*Rafinesque*). — MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Shoals Cr. (!)—Richland Cr., Wales (!!)—Flint R., Gurley (!)—Paint Rock R., Paint Rock (!)—Sequatchie R., Dunlap (Walker coll.)

Ball ('22 p. 109) has fixed the diameter of 57 per cent as the upper limit of obesity in this form, and specimens from the above localities thus fall under it. Yet at the Mussel Shoals also the variety is represented (see next form.)

A common form in the Interior Basin, in the Cumberland, lower and upper Tennessee, represented in large rivers by *C. tuberculata granifera*. Its center of origin is obscure.

21. *Cyclonaias tuberculata granifera* (*Lea*).—Dixie (!!) MS (Hinkley) (!).

Specimens with the dia. over 57 per cent are found at Dixie and at the Mussel Shoals. At the latter place the two forms are associated and pass into each other: of 21 specimens at hand, 7 belong to the *granifera*-type (dia. 58-63 per cent), but several of the others come very close to it (dia. ranging from 45-57 per cent). Thus also in the Tennessee the rule holds good, that *granifera* is the more swollen form found in the lower parts of the rivers. The region of transition of the two forms is just at the Mussel Shoals. From Dixie I have only two specimens, with the dia. of 58 and 60 per cent.

As to the general distribution, the same is true as in *tuberculata*, but of course, being absent in the upper parts of all streams, this form is not found in the Tennessee above the Mussel Shoals.

22. *Plethobasus cooperianus* (*Lea*).—Dixie (!!)—Bridgeport (Walker coll.)—Limestone Cr., Mooresville (Walker coll.)

Apparently rare in the lower Tennessee, and not reported from the Mussel Shoals, but it should be remembered that this species is easily confounded with *Quadrula pustulosa*. It goes into the upper Tennessee up to the Knoxville region, but it is rare there (Ortmann, '18 p. 543). It is not rare in the Cumberland (Wilson & Clark, '14 p. 60), and in the Ohio, and probably is an Ohio-type, which immigrated into the Cumberland and Tennessee, remaining restricted to the larger rivers.

23. *Plethobasus cyphyus* (*Rafinesque*).—Dixie (!!)—MS (!!).

In the lower Tennesee drainage sparingly in the main river, but not in the tributaries; also in the Cumberland only in the main river (Wilson & Clark, '14 p. 57). In the upper Tennessee it goes into some of the tributaries, ascending, in the Clinch, into Virginia (Ortmann, '18 p. 544.) It is in the Interior Basin, chiefly in the Ohio River, which might be its center of radiation: but this is not positively assured.

(*) 24. *Lexingtonia dolabelloides* (*Lea*).—MS (!!) — Bridgeport (Walker coll.)—Middle Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Paint Rock R., New Hope (!)—Paint Rock (!).

The Mussel Shoals are the type locality for several of the synonyms of this form (*thorntoni Lea, mooresianus Lea, subglobatus Lea, circumactus Lea*). The Carn. Mus. has a set from this locality, collected by Smith, and a single specimen (*F.*) collected by myself. It is abundant in middle Duck R. (associated with and passing into *conradi* in the upstream direction; see: Ortmann, '24 p. 18), and is present in the lower parts of Limestone Cr., Flint R., and Paint Rock R. In the upper Tennessee it goes into the lower parts of the larger tributaries (Ortmann, '18 p. 545). The synonym *subglobatus* has been reported by Lea also from Cumberland River at Nashville, but its presence in this system has never been confirmed, and it seems to be absent. It is a large-river-form, passing toward the headwaters into the next form, and a Cumberlandian type, found positively only in the Tennessee drainage from the Mussel Shoals upward.

(*) 25. *Levingtonia dolabelloides conradi* (*Vanatta*).—Middle and upper Duck R. (!!)—Lower Elk R. (Conrad)—Flint Cr. (Conrad)—Flint R., Gurley (!)—Maysville (!)—Paint Rock R., New Hope (!)—Paint Rock (!)—Princeton (!).

This form gradually takes the place of *dolabelloides* in the upstream direction (see: Ortmann, '20 p. 294-296), and it is found in tributaries of the lower as well as the upper Tennessee (Ortmann, '18 p. 546). The type localities of Conrad's *maculatus* (for which *conradi* was introduced) are in "Elk and Flint Rivers" (the latter meaning Flint Creek.) A Cumberlandian type, restricted to the Tennessee drainage.

26. *Pleurobema cordatum* (*Rafinesque*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R. (!!)—Paint Rock R., Paint Rock (!).

Rather abundant in the main river, rare in Duck and Paint Rock Rivers, generally favoring larger rivers, as is also the case in the rest of its range: upper Tennessee, Cumberland, and Interior Basin, possibly with its center in the latter, but we cannot be sure about this.

27. *Pleurobena cordatum plenum* (*Lea*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (!).

Merely a variation of the typical *cordatum*, and always associated with it all over its range, but generally rare. My specimens from the lower Tennessee are the best representations I have ever seen of this form.

28. *Pleurobema cordatum catillus* (*Conrad*).—MS (!)—Bridgeport (!)—Duck R. (!!)

Accompanying the typical *cordatum* in the main river, but rare; more abundant in Duck River. It has the same relation to the main form in the upper Tennessee (Ortmann, '18 p. 548), and in the Cumberland (see: *solida*, Wilson & Clark, '14 p. 61: "occasional"; I have found it at Burnside, Pulaski Co., Ky.) It is much more abundant in the Ohio and its larger tributaries, and West of the Mississippi it exists without *cordatum*. This again indicates, that the center of the *cordatum*-group might be in the Interior Basin.

29. *Pleurobema cordatum pyramidatum* (*Lea*). — MS

(Hinkley)—Decatur (Hinkley)—Bridgeport (Walker coll.) —Duck R. (!!).

The same holds good in the lower Tennessee as for *catillus*. It even seems to be less frequent in the main river, but in Duck it is more numerous, and also in the upper Tennessee, where it goes a little farther up than the other *cordatum*-forms. In the Cumberland it is also rare (Wilson & Clark, '14 p. 62): I obtained it at Burnside. Like the other forms of the group, it is abundant in the Ohio-drainage, and exists also West of the Mississippi.

30. *Pleurobema clava* (*Lamarck*).—MS (!)—Sequatchie R., Jasper (Walker coll.).

The Carn. Mus. possesses four specimens from Tuscumbia, Ala. (Mussel Shoals) from the *old* Smith collection, which are typical *clava*, and I have seen this species in the Walker collection from Jasper. For the rest, it is unknown from the lower as well as the upper Tennessee*), and represented there by forms of the *oviforme*-group. The specimens reported by Wilson & Clark ('14 p. 57) from tributaries of the upper Cumberland drainage (South Fork and Rockcastle R.) may have been misidentified, and may belong to *oviforme*, which positively exists in West Fork Stones River, Murfreesboro, Rutherford Co., Tenn., where I collected myself a fine set of it. Two specimens of typical *clava* in Carn. Mus. (from the Juny collection), labelled "Cumberland R., Tenn.," have no exact locality, and are thus not convincing. Thus the presence of *clava* in the Cumberland remains doubtful. It is known as a common form in the smaller streams of the Ohio drainage, and its presence in the lower Tennessee indicates, that it has reached these parts coming from the Ohio.

(*) 31. *Pleurobema oviforme* (*Conrad*). — Middle and upper Duck R. (!!)—Bear Cr., Burleson (Walker coll.)—Elk R., Fayetteville (Walker coll.)—Estill Springs (!)—Boiling Fk., Cowan (!)—Flint R., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!).

* A specimen in the Walker collection, labelled "Elk River, Shelbyville," cannot be considered, because Shelbyville is on Duck River.

This form of moderate obesity belongs to streams of medium size, and thus it is absent in the Tennessee proper, but found in the more important tributaries. In the Tennessee at the Mussel Shoals it is represented by the more swollen *holstonense*, and in the headwaters it passes into the compressed *argenteum*. Similar conditions prevail in the upper Tennessee (Ortmann, '18 pp. 551-554, also: '20 pp. 299, 300).

This is a Cumberlandian type, found also in the upper Cumberland drainage, at least in West Fork Stones River (see above under *clava*). In the Interior Basin it is missing, but represented by *P. clava*, and it may be, that the two are only varieties of one species. However, in the Cumberland region I do not know of any intergrades, while in the upper Ohio specimens of *clava* occasionally incline toward *oviforme*.

(*) 32. *Pleurobema oviforme holstonense* (*Lea*).—MS (!!)—Middle Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Being the form of the larger rivers, *holstonense* is found at the Mussel Shoals, in middle Duck R. (below the range of *oviforme*, see: Ortmann, '24 p. 21), and in the lower parts of Limestone Cr. and Paint Rock River. In the upper Tennessee it goes into the lower parts of the larger tributaries. From the Cumberland it is not known, yet it may be present, since typical *oviforme* is in one of its tributaries.

The type-locality of *holstonense* is Holston R., Tenn., *not* Tuscumbia, as given by Simpson ('14 p. 739). But the Mussel Shoals are type-locality for the synonyms: *mundus Lea*, *lawi Lea*, and *bellulus Lea*.

(*) 33. *Pleurobema oviforme argenteum* (*Lea*).—Upper Duck system (!!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Hurricane Cr., Gurley (Walker coll.)—Paint Rock R., Princeton (Walker coll.)—Dry Fk., Hollytree (Walker coll.).

This compressed form of the headwaters is found under similar conditions in the lower Tennessee drainage as in the upper, yet it does not seem to be so generally distributed as in the tributaries above the Knoxville region. It is best developed in upper Elk River, where it also attains the large size, often seen in the upper Tennessee. It has not been

reported from the Cumberland drainage, and it should be emphasized that this large and flat type is nowhere found within the range of *P. clava* in the Ohio drainage.

34. *Elliptio crassidens* (*Lamarck*).—Dixie (!!)—MS (!)—Decature (Hinkley).—Bridgeport (Walker coll.)—Lower Duck R., rare—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Sequatchie R., Jasper (!).

A species generally common in the Interior Basin, in Cumberland, lower and upper Tennessee, but mainly restricted to the larger rivers. The center of origin is obscure, but may be in the Interior Basin.

35. *Elliptio dilatatus* (*Rafinesque*).—Dixie (!!) — MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., common (!!)—Shoals Cr. Bailey Springs (!!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Sequatchie R., Dunlap (!).

Of wide distribution in the Mississippi, Ohio, Cumberland, and Tennessee drainages, going up in the latter to the headwaters. Also abundant in our region. The center of radiation is thus obscure.

36. *Lastena lata* (*Rafinesque*).—MS (!!)—Duck R., Columbia (!!)—Lower Elk R., (Walker coll.).

This species is in the Walker collection also from the Mussel Shoals, and I had the good luck of finding a dead shell at Florence. Known from the Ohio drainage, from the Cumberland (Wilson & Clark, '14 p. 55), and the upper Tennessee (Ortmann, '18 p. 556). It is altogether a rare shell, the center of distribution of which cannot be ascertained.

(*) 37. *Lasmigona* (*Alasminota*) *holstonia* (*Lea*).—Uppermost Duck R. (!!)—Jones Cr., Bridgeport (!)—Battle Cr., (Walker coll.).

This species is characteristic for small streams, and is rather abundant in the headwaters of the upper Tennessee (Ortmann, '18 p. 557). No localities are known from the Cumberland drainage, and this fact is additional evidence against the assumption, that *Alasmodon badium Raf.* might be the species (see: Ortmann, l. c. and Ortmann & Walker,

'22 p. 36). The three localities given above for the lower Tennessee are also in small streams.

This is a Cumberlandian type, restricted, thus far, to the Tennessee drainage, but also found in the headwaters of the Alabama system, see: Ortmann, '23 pp. 83, 129).

38. *Lasmigona* (*Lasmigona*) *costata* (*Rafinesque*).—MS (!)—Duck R., common (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Lawrenceburg (!!)—Elk R., Fayetteville (!)—Estill Springs (!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (!).

As elsewhere, this species is rare in the large rivers, but more abundant in the tributaries, and probably is of general distribution in our region. It is extremely abundant in the Interior Basin, chiefly in the Ohio drainage, as well as in Cumberland and upper Tennessee. Hence its center of origin is obscure.

39. *Lasmigona* (*Pterosyna*) *complanata* (*Barnes*). — Lower Duck R. (!!).

Only in the lower Duck R., at Centreville, Ben, and Columbia (Ortmann, '24 p. 23,) and never found at any other place in the rest of the Tennessee drainage; but it probably exists in the lower Tennessee from the mouth of Duck R. downward. It is present in the lower Cumberland, and widely distributed in the Interior Basin. Thus it undoubtedly is an immigrant from the lower Ohio.

40. *Anodonta imbecillis Say.*—Paint Rock R., Paint Rock (!)—Princeton (!).

This species has never been reported before from any part of the Tennessee drainage; it is, however, present in the Cumberland drainage: Wilson & Clark ('14)give it from Haynes Lake, Clarksville, Montgomery Co., Tenn., from East Fork Stones R., Walterhill, and from West Fork Stones R., Murfreesboro, Rutherford Co., Tenn. I found it myself at the latter place on August 30, '21.

It has a wide distribution in the Interior Region, the basin of the Great Lakes, and in southern streams running to the Gulf, including the Alabama-system. The scattered localities in the Cumberland and lower Tennessee indicate a

rather modern immigration, but the direction of it is obscure. It is very probable, that this species possesses exceptional means of dispersal.

41. *Anodonta grandis Say.*—Duck R., Shelbyville (!!)—Flint Cr., Flint (!!)—Mountain Fk., New Market (!).

Only found at three isolated localities in the lower Tennessee region, and in the upper Tennessee system in a pond near Knoxville (var. *gigantea Lea*), and in Emory R., Wartburg, Morgan Co., Tenn. (Ortmann, '18 p. 558, '24 p. 23.) Specimens from Shelbyville and Wartburg represent rather typically the creek-form, but the color of the nacre inclines to purplish or salmon tints. Two specimens from New Market, collected by H. E. Wheeler, Aug. '10, are large and thick-shelled, and strongly resemble the var. *gigantea* in size and shape, but have perfectly white nacre. Six specimens from Flint Creek are the typical creek-form in shape, but rather thin-shelled, and have a peculiar deep copper-color in the nacre, whitish toward the margins. The latter come from a small stream with sluggish current and sandy-muddy bottom.

This species is also known from the Cumberland drainage (see: Ortmann, '24 p. 23), but only from a few, scattered localities; for the rest, it has an immense range in the Interior Basin, southern Coastal Plain, and region of the Great Lakes. It forms thus a case parallel to *A. imbecillis*, and is to be regarded as an immigrant in the Cumberlandian region. At any rate, both *imbecillis* and *grandis*, surely had not their centers of origin in this region.

(*) 42. *Alasmidonta* (*Pressodonta*) *minor* (*Lea*).—Upper Duck and upper Buffalo R. (!!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Sequatchie R., Pikeville (!).

A species favoring small streams. It seems to be rare in the lower Tennessee system. In the upper Tennessee it is abundant in the headwaters (Ortmann, '18 p. 560). It is also in the headwaters of the Cumberland River (Wilson & Clark, '14 p. 55).

In addition, it is found in the headwaters of the Kentucky drainage (see: Danglade, '22 p. 5): I have seen specimens collected by Danglade in North Fk., Kentucky R.,

Whitesburg, Letcher Co., Ky., and I collected it myself in Dix R., Hedgeville, Boyle Co., and Hanging Fork, Lytle, Lincoln Co., Ky., (Sept. '24), where it was rather abundant. It also has been reported by Price from the Green River drainage, in Gasper Cr., Warren Co., Ky., but has not been recently found in this system.

It is to be regarded as a Cumberlandian type, which has crossed over into the Kentucky drainage in the region, where the latter comes in close contact with that of the Cumberland.

43. *Alasmidonta* (*Decurambis*) *marginata* (*Say*).—Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Elk R., Fayetteville (!)—Flint R., Gurley (!)—Paint Rock R. Paint Rock (!)—Trenton (!).

Since also this species has a preference for smaller rivers, it is not astonishing, that it has not been found in the Tennessee proper in our region. It is, with the same restrictions, widely distributed in the Interior Basin, chiefly in the Ohio drainage, in the Cumberland and upper Tennessee. No specific center of origin is indicated.

("*Unio diversus*" Conrad (*Alasmidonta diversa* Simpson, '14 p. 500), a spurious species from Shoals Creek, has never been recognized, and it is even doubtful, whether it is an *Alasmidonta*.)

(*) 44. *Pegias fabula* (*Lea*).—Bluewater Cr. (Walker coll.)—Elk R., Estill Springs (!).

Rare in the lower Tennessee, and only in small streams, exactly as in the rest of its range in the upper Tennessee (Ortmann, '18 p. 562). It has not been found in Duck River, but has been reported from Cumberland and Stones R. (Lea). In recent times it has been found in this drainage, only in Rockcastle River (Wilson & Clark, '14 p. 55.)

It is a characteristic Cumberlandian type, absent from the Interior Basin.

45. *Strophitus rugosus* (*Swainson*).—MS (!)—Duck R. (!!)—Elk R., Estill Springs (!).

It is remarkable that this species, common all over the Interior Basin, and common in the Cumberland and upper Tennessee, seems to be much rarer in the lower Tennessee. Yet it has been found in both, tributaries and the main

river: in the Carn. Mus. are specimens collected by Smith at the Mussel Shoals, and Hinkley gives it from the same place. It is fairly abundant in the Duck R. drainage.

Being of wide distribution, the centre of origin is obscure.

46. *Ptychobranchus fasciolare* (*Rafinesque.*)—Dixie (!!)—MS (!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Elk R., Estill Springs (!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!)—Trenton (!).

Not rare in the lower Tennessee, both in main river and tributaries, also in Cumberland and upper Tennessee drainages and in the Ohio system. This wide distribution would not permit the location of its centre of origin. Yet while this species (and the genus) is missing in the whole Mississippi drainage above Cairo*, it is represented in the Ozark region by another, closely allied species *P. occidentale* (*Conr.*), and in the Alabama drainage by *P. greeni* (*Conr.*). In addition, there is another species of the genus in the Cumberlandian region: *P. subtentum* (*Say*). This makes is probable, that the center of origin of the genus was located in the Cumberland region, when it was still connected with the Ozarks, i. e. before the Mississippi Embayment was formed in the later Cretaceous. The present spceies would then be an immigrant from the Cumberland region into the Ohio. I only indicate here this possibility, reserving further discussion for an other occasion.

Two specimens found by myself in Flint Creek are very peculiar, being extremely compressed and rather thin. I did not recognize them as belonging here, till I had examined the soft parts, which, both being females, had the characteristic structure of *Ptychobranchus*. As has been mentioned, the bottom here was sandy mud, with sluggish current.

(*) 47. *Ptychobranchus subtentum* (*Say*).—MS (Hinkley—Duck R. (!!)—Shoals Cr. (!)—Elk R., Estill Springs (!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Maysville (!).

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* Reported only once from Wisconsin R., Wis., without exact locality, by Lapham (Pr. Ac Phil. '60), and probably by mistake, since nobody else has found it in this vast region.

In the Cumberland and upper Tennessee not rare, locally abundant, chiefly toward the headwaters (Wilson & Clark, '14 p. 53 and Ortmann, '18 p. 564). The same holds good, apparently, for the lower Tennessee. It is a Cumberlandian type, absent in the Interior Basin.*

48. *Obliquaria reflexa Rafinesque.*—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Duck R. (!!)—Paint Rock R., Paint Rock (!).

This belongs, in the lower Tennessee, to the main river and the lower parts of some of the tributaries. This is in keeping with its ecological preferences elsewhere, in the Interior region, in the Cumberland and upper Tennessee, where it is generally missing in smaller streams. It has a wide distribution, extending also well over the Gulf Plain. No definite center of origin can be pointed out.

49. *Cyprogenia irrorata (Lea)*—MS (!)—Bridgeport (Walker coll.)—Duck R., very rare.

This species is widely distributed in the Ohio, Cumberland, and upper Tennessee drainages, preferring the larger rivers. From this distribution, a centre of origin cannot be pointed out. Yet considering the distribution of the *genus*, it is remarkable, that in the upper Mississippi drainage (above Cairo), this genus is entirely missing (a case parallel to that of *Ptychobranchus*), but that it turns up again in the Ozark region as *C. aberti (Conr.)*. It has no representative in the Alabama drainage, and in this it differs from *Ptychobranchus*. This distribution has a similar tendency to show, that there was an old connection between the Cumberland Plateau and the Ozarks, and that *Cyprogenia* might have had its center in this region, immigrating subsequently into the Ohio drainage.

(*) 50. *Dromus dromas (Lea)*.—MS (!) — Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Elk R. (Conrad).

Present in the Cumberland R. (Wilson & Clark, '14 p. 53) and in the upper Tennessee up to the Knoxville region (Ortmann '18 p. 566). It is the form of the larger rivers,

* Call mentions this species from Green and Salt Rivers, Ky., but this is extremely doubtful.

which is also shown in the lower Tennessee. A characteristic Cumberlandian type, not found outside of this region.

(*) 51. *Dromus dromas caperatus* (*Lea*).—Limestone Cr., Mooresville (Walker coll.).

This is the form of smaller rivers, both in the Cumberland and upper Tennessee drainages (Wilson & Clark, l. c. and Ortmann, l. c.) But, since it decidedly avoids the smallest streams of the headwaters, it is understood why it is rare in the lower Tennessee drainage. It is also typically Cumberlandian.

52. *Obovaria* (*Obovaria*) *retusa* (*Lamarck*).—Dixie (!!) —MS (Hinkley) (Walker coll.)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Duck R., rare.

A species of large rivers, most abundant in the Ohio drainage, but also in the Cumberland (Wilson & Clark, '14 p. 52). In the upper Tennessee it goes to the Knoxville region, but is very rare (Ortmann, '18 p. 567). This would indicate, that originally this species belongs to the Ohio, and is an immigrant in the Cumberland as well as the Tennessee.

53. *Obovaria* (*Obovaria*) *subrotunda* (*Rafinesque.*) — Middle Duck R. (!!).

It is very remarkable, that this form of larger rivers has not been found in the lower Tennessee, except in Duck River, although the small-stream-form (*O. surotunda lens*) is rather abundant in this region. Probably it has been accidentally overlooked. This species also belongs to the Ohio and Cumberland drainage. Although Wilson & Clark ('14 p. 52, under *circulus*) do not separate this form from *lens*, I have found typical *subrotunda* in the Cumberland at Burnside, Pulaski Co., Ky., (Sept. 1, '24). *O. subrotunda* is very rare in the Knoxville region (Ortmann, '18 p. 567), and this would suggest an immigration from the Ohio system.

54. *Obovaria* (*Obovaria*) *subrotunda lens* (*Lea*).—Middle and upper Duck R. (!!)—Bear Cr., Burleson (!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.) — Flint R., Maysville (!)— Hurricane Cr., Gurley (!)—Paint

Rock R., Paint Rock (!)—Hollytree (!)—Princeton (!) — Sequatchie R., Jasper (!)—Dunlap (Walker coll.).

Abundant in the tributaries of the lower Tennessee; also present in the upper Tennessee, but very rare (Ortmann, '18 p. 568). It has not been mentioned from the Cumberland by Wilson & Clark, but is probably present in the tributaries (see: Ortmann, '24 p. 26), and some of the records given by Wilson & Clark for *"circulus"* surely belong to this form. With the main species, this form probably is an immigrant from the Ohio system.

55. *Obovaria* (*Pseudoön*) *olivaria* (*Rafinesque*).—Dixie (!!)—MS (!!).

Reported from the Mussel Shoals by Hinkley, collected there by Smith and myself, and apparently rare; yet abundant at Dixie. Unknown from the rest of the lower as well as the upper Tennessee region. It is not rare in the Cumberland (Wilson & Clark, '14 p. 52), and widely distributed in larger rivers in the Interior Basin: this indicates, that its center of origin in the latter parts.

56. *Actionaias carinata* (*Barnes*).—Duck R., Ben and Columbia (!!).

I have pointed out ('24 p. 27), that the Duck R. form is the typical *carinata*, not the var *gibba*. When I studied the vast material collected by Smith at the Mussel Shoals, I was astonished, that no specimens belonging here were among it. I suspected that possibly the most common shell at this place had been neglected, just because of its frequency. But when I collected myself at Florence, I did not see a single specimen, although I was looking for this form. Thus the absence (or scarcity) of *A. carinata* at this place is real. Further, I was unable to discover any shells of this type in the piles of the clam-diggers at Dixie, which is significant, since this is one of the best commercial shells. Indeed, the "muckett" was known to the clam-diggers, but considered as extremely rare and precious. Also in Duck R., where I found it, it was comparatively rare.

I have no material before me, which enables me to say, what form of *carinata* is in the Tennessee in northern Alabama. When I inspected specimens in the Walker collection,

I recorded them as *gibba*, and Call ('85 p. 35) expressly states, that the form of the Mussel Shoals and in the Holston is a "peculiar dwarfed" one, which would indicate *gibba*.

This much is sure, that typical *carinata* is in Duck R., and since this species is extremely abundant in the Ohio drainage and other parts of the Interior Basin, we are to look for its center in these parts.

57. *Actinonaias carinata gibba* (*Simpson*).—MS (Call)—Bridgeport (Walker coll.).

If present at all in this part of the Tennessee (see above under *carinata*), this form surely is rare. This is in sharp contrast to its abundance in the Cumberland and the upper Tennessee.

I regard this now as the Cumberlandian representative of *A. carinata* of the Interior Basin: the latter, however, has also advanced into the lower Tennessee and Duck River. Yet further investigations should be made, in order to settle both the taxonomic and geographical relations of these two forms.

(*) 58. *Actionaias pectorosa* (*Conrad*).—MS (Hinkley)—Duck R. (!!)—Bear Cr., Burleson (!)—Lower Elk R. (Conrad)—Elk R., Fayetteville (!)—Estill Springs (!)—Flint R., Gurley (!)—Sequatchie R., Dunlap (Walker coll.)

The lower Elk R. is the type-locality for this species. It is not rare in the lower Tennessee region, chiefly in the tributaries. It is known from the Cumberland system (Wilson & Clark, '14 p. 49), and also from the upper Tennessee (Ortmann, '18 p. 569).

A Cumberlandian type, missing outside of this region.

59. *Truncilla truncata Rafinesque.*—MS (!)—Duck R., rare (!!)—Bear Cr., Burleson (!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

Locally abundant in the lower Tennessee (Mussel Shoals and Paint Rock), in larger and smaller rivers. Widely distributed in the Interior Basin, region of the Great Lakes, and Gulf drainage. Also present in the Cumberland and upper Tennessee, but rare. The center of origin plainly is not in the Cumberland region, but its exact location cannot be given.

60. *Truncilla donaciformis* (*Lea*).—MS (!) — Lower Duck R., rare (!!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

Found frequently associated with the preceding species, but is generally somewhat less abundant. The distribution apparently has been along the same lines, but it should be noted, that *donaciformis* is missing in the upper Tennessee, where *truncata* is found.

61. *Plagiola lineolata* (*Rafinesque*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., rare.—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

In the main river, and occasionally in the lower parts of some of the tributaries. Abundant in the Cumberland (Wilson & Clark, '14 p. 52), but rare in the upper Tennessee (Ortmann, '18 p. 571.) It generally prefers larger rivers, and is widely distributed in the Interior Region, extending considerably southward over the Gulf Plain. According to the general character of the distribution, and the scarcity in the upper Tennessee, it probably is *not* a Cumberlandian type, but immigrated from the Ohio.

62. *Leptodea leptodon* (*Rafinesque.*).—MS (!) — Duck R., rare.

Reported by Hinkley from the Mussel-Shoals, and one specimen in the Carn. Mus., collected by Smith. Reported from Duck R. by Hinkley & Marsh (see: Ortmann, '24 p. 28). Rare in the Cumberland and upper Tennessee (Wilson & Clark, '14 p. 51; Ortmann, '18 p. 571). Widely distributed in the Interior Basin with an extension of the range southward, but apparently always a rare shell. No distinct center of origin is indicated.

63. *Leptodea fragilis* (*Rafinesque*).—MS (!!)—Duck R. (!!)—Spring Cr., Tuscumbia (Call)—Shoals Cr. (!)—Flint, Cr., Flint (!!)—Paint Rock Cr., Paint Rock (!)—Sequatchie R., Jasper (!).

Of very wide distribution, from the Gulf Coastal Plain, all over the Interior Basin to the Great Lakes, including Cumberland, lower and upper Tennessee. It prefers larger

rivers with muddy bottom, but is also found in gravel. Center of origin thus obscure.

64. *Proptera alata* (*Say*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Duck R. (!!)—Flint Cr., Flint (!!) —Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Sequatchie R., Jasper (!)—Dunlap (Walker coll.).

Very similar to the preceding species in its distribution, with the exception, that it is represented in the South by a somewhat different form, *P. purpurata* (*Lam.*). The center of origin is not clear.

65. *Proptera laevissima* (*Lea*).—Flint Cr., Flint (!!).

This species has never before been reported from any place in the Tennessee drainage. It is rare in the lower Cumberland (Wilson & Clark, '14 p. 51.)

For the rest, it is known from the Interior Basin, chiefly in larger rivers, and it is evident, that it has entered Cumberland and Tennessee Rivers coming from the lower Ohio. We are to expect that it will be found, when looked for, in the lowermost Tennessee.

The specimen found by myself in sandy-muddy bottom of Flint Creek is a male, less than half-grown, but characteristic in every respect.

(*Carunculina parva* (*Barnes*).—This species has been reported by Call ('85 p. 41) from Tuscumbia, Ala. It has never been found again at this place, nor elsewhere in our region: thus this record probably is a mistake. The species is missing in the upper Tennessee, but exists in certain tributaries of the Cumberland.)

(*) 66. *Carunculina moesta* (*Lea*).—Duck R. (!!) —Bear Cr., Burleson (!)—Cypress Cr., Florence (!!)—Shoals Cr., Bailey Springs (!!)—Flint Cr., Flint (!!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Hollytree (!)—Princeton (!).

A Cumberlandian type, apparently rather generally found in tributaries of the lower Tennessee, and widely distributed, but local, in smaller streams of the upper Tennessee. (Ortmann, '18 p. 573). Also in small streams in the Cumberland drainage (Wilson & Clark, '14 p. 51, as *glans*): I found it

myself in West Fork Stones R., Murfreesboro, Rutherford Co., Tenn., Aug. 30, '21.

In addition, this species is found in the headwaters of the Alabama drainage, generally called there *corvunculus;* and further, in the Ozark uplift (Ortmann, '21 p. 89 and Naut. '24 p. 100). The latter circumstance again indicates the former connection of the Ozarks with the Cumberland Plateau, before the Mississippi Embayment was in existence. In the Interior Region and southward, along the Mississippi lowlands, this species is represented by the closely allied *C. glans* (*Lea*).

(*) 67. *Carunculina moesta cyclindrella* (*Lea*).—Upper Duck R. and trib. (!!)—Elk R., Estill Springs (!)—Flint R., Gurley (!).

The type locality of this form is Duck River. I found it there myself, and in Buffalo River (Ortmann, '24 p. 29). It occurs also in the upper Tennessee region, but only as an occasional variation of *C. moesta,* and associated with the latter*), and for this reason I think it better, to consider it a variety of *moesta.* It has never been found in the Cumberland drainage, nor anywhere else.

(*) 68. *Conradilla caelata* (*Conrad*).—MS (!)—Duck R. (!!)—Lower Elk R. (Conrad)—Flint Cr. (Conrad).

"Tennessee, Elk, and Flint rivers" (the latter is Flint Creek) are the type localities of this species. From the Mussel Shoals it has been reported by Hinkley ('06), and the Carn. Mus. possesses three fine, large specimens collected by Smith. It is a rare shell also in the upper Tennessee region (Ortmann, '18 p. 574). It is not known from the Cumberland, which is an additional argument against making it a synonym of *Lemiox rimosus* (*Raf.*), which is said to be from the Cumberland (see: Ortmann & Walker, '22 p. 56).

It is found nowhere else, and is one of the most interesting shells of the Cumberlandian fauna.

(*) 69. *Medionidus conradicus* (*Lea*).—MS (!)—Duck

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* In my paper on the upper Tennessee shells ('18 p. 573) I did not separate this form. I want to state here, that the *cylindrella*-type is represented by some specimens from Little Pigeon R., Sevierville, Sevier Co., Tenn.

R. (!!)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Flint Cr. (Conrad)—Flint R., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!).

A common species in the Cumberland, upper and lower Tennessee, distinctly preferring small streams and the headwaters. It has not been reported, hitherto, from the main river in Alabama, but the Carn. Mus. possesses a single individual from the Mussel Shoals collected by Smith. This is one of the most characteristic Cumberlandian types, chiefly on account of its abundance. Related forms, belonging to the same genus, are found only in the Alabama drainage, and certain parts of Georgia and Florida: but these are all different species (Ortmann, Naut. '23 p. 58; '24 p. 99).

70. *Micromya fabalis* (*Lea*).—Duck R., (!!).

Compare what I have previously said about the distribution of this species ('24 p. 30 and 40). It is in Duck River and in the upper Tennessee, but not in the Cumberland, nor at any place in the lower Tennessee, outside of Duck R. It is abundant in small streams of the Ohio drainage. Thus it is an exceptional and isolated case, hard to classify.

(*) 71. *Micromya trabalis* (*Conrad*).—MS (!!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

The metropolis of this species seems to be in Cumberland River, in the upper parts. In the lower Tennessee, it apparently is rare. The same is the case in the upper Tennessee, where it has been found in Chicamauga Creek and Hiwassee River, and also (a single individual) in Clinch R., Va. (see Ortmann, '18 p. 576). But an additional specimen has come to hand, from the Sterki collection, which is labelled: Emory River. In the latter river, I have found *M. perpurpurea* (*Lea*), with the nacre only in part of purple color. This form, with purple nacre, represents *trabalis* in Powell, Clinch, and Holston Rivers. There are a few specimens from Holston and Clinch Rivers, where the purple color of the nacre is not so intense, and shades to white, and thus it would be possibly better, to regard *perpurpurea* as a variety of *trabalis*.

A Cumberlandian type, not found outside of the Tennessee and Cumberland drainages.

(*) 72. *Micromya nebulosa* (*Conrad*).—MS (Lea) — Upper Buffalo R. (!!)—Bear Cr., Burleson (!)—Cypress Cr., Florence (!!)—Shoals Cr., Bailey Springs (!!)—Lawrenceburg (!!)—Bluewater Cr. (!)—Lower Elk R. (Call, as: *jonesi*)—Estill Springs (!)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Crow Cr., Sherwood (!)—Battle Cr., Dove (!)—Little Sequatchie R., Sequatchie (!).

Abundant in smaller streams of the lower Tennessee drainage, but reported also from the Mussel Shoals by Lea (as *U. scitulus* and *planicostatus*). Very abundant under similar conditions in the upper Tennessee region (Ortmann, '18 p. 577), and present also in the Cumberland drainage*).

This should be regarded as a Cumberlandian type, although it is also found in the headwaters of the Alabama drainage. In the Ohio- and Lakes-drainage it is represented by *M. iris* (*Lea*), and this form, chiefly the var. *novi-eboraci* (*Lea*), is very hard to distinguish. It is also to be mentioned that a form resembling *M. iris* is found in the Ozarks (Hinkley, Utterback, and Carn. Mus.)

The taxonomic relations of this species, also to the next species, *M. taeniata*, and the distributional features require further investigation.

(*) 73. *Micromya taeniata* (*Conrad*).—MS (Lea)—Duck and Buffalo R. (!!)—Shoals Cr. (!)—Elk R., Estill Springs (!)—Flint Cr. (Conrad)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!).

As to the synonymy of this species, and its relation to *M. nebulosa*, compare Ortmann, '24 p. 31. Although I have recently found additional material in the Cumberland drainage, I have not been able to distinguish the three forms admitted by Wilson & Clark ('14 p. 49: *taeniata Conr., picta*

* See: Ortmann, '24 p. 31. To the localities mentioned there (Riverhill, McMinnville, Burnside) should be added: New River, New River, Scott Co., Tenn., coll. Aug. 30, '24.

Lea, and *punctata Lea*); but since I have good material of soft parts, I hope to be able to clear up this question in the future.

As matters stand now, the distribution of this species is in the smaller streams of the Cumberland drainage and of the lower Tennessee; but it is missing in the upper Tennessee. It is found nowhere else, and is thus a Cumberlandian type, peculiarly restricted.

Flint Creek is the type locality of Conrad's *taeniatus;* the Mussel Shoals are type-locality for Lea's *fucatus* and *punctatus.*

(*) 74. *Micromya vanuxemensis* (*Lea*).—MS (!) —Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!) —Flint Cr., Flint (!!)—Flint R., Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Jones Cr., Bridgeport (!)—Battle Cr., S. Pittsburg (!)—Sweden Cr., Ketchall (!)—Stream, Jasper (!)—Little Sequatchie R., Sequatchie (!).

As I have pointed out previously ('24 p. 32), the form of this species in the lower Tennessee is not the normal one, but corresponds to that called by Lea *pybasi,* with the shell more elongated*, both in the male and the female, and the postbasal constriction of the true *vanuxemensis* missing. Thus these specimens distinctly approach *M. lienosa* (*Conr.*) of the Alabama system. The essential differences between them have yet to be studied. But specimens of the *pybasi*-type are also found in the upper Tennessee, chiefly in larger streams, and the transition of these into *vanuxemensis* is very gradual and insensible, so that we cannot separate them sharply. On the other hand, here and there in the lower Tennessee, specimens turn up inclining distinctly towards typical *vanuxemensis,* being shorter, and having, in the female, indications of the constriction. The nacre of the lower Tennessee specimens generally is coppery purple, rarely pale to whitish.

A Cumberlandian shell, represented abundantly in the low-

* Often more so than in Lea's figure, but very variable in this respect.

er and upper Tennessee, chiefly in small streams; apparently rare in the Cumberland system. Not found outside of this region, but represented in the upper Alabama drainage by *M. vanuxemensis umbrans* (*Lea*) (Ortmann, Naut. '24 p. 137). Also *M. lienosa* (*Conr.*) of the Gulf drainage might be only a form of this type.

The Mussel Shoals are the type locality of Lea's *pybasi.*

75. *Ligumia recta latissima* (*Rafinesque*).—Dixie (!!)—MS (!)—Bridgeport (Walker coll.)—Duck R., rare.—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Widely distributed in the Interior Basin, in the Cumberland and Tennessee drainages, chiefly in larger rivers, but entering also some smaller ones. No definite center of dispersal can be assigned to this species.

76. *Lampsilis anodontoides* (*Lea*).—Dixie (!!)—MS (Hinkley)—Lower Duck R. (!!).

The typical *anodontoides* belongs to larger rivers with sand and gravel bottom. At Dixie and in the lower Duck I collected it myself. It has a wide distribution in the Interior Basin, extending considerably southward. It exists in the Cumberland (Wilson & Clark, '14 p. 50), but has not been found above the Mussel Shoals in any part of the Tennessee drainage. Thus its center must be located in the Interior Basin, whence it immigrated into the Cumberland and lower Tennessee.

77. *Lampsilis anodontoides fallaciosa* (*Smith*).—MS (!!)—Flint Cr., (!!).

This form is not always sharply separated from the main species: thus I found at Florence a dead shell, resembling in shape *fallaciosa,* but in color rather *anodontoides.* At this place, both rocky-gravelly and muddy bottom exist. The specimens from Flint come from sandy-muddy bottom and sluggish water, and it seems to me, that *fallaciosa* simply is the mud-form of *anodontoides.* Thus its distribution is closely connected (also in the Cumberland) with that of the latter, and apparently subject to the same laws.

(*) 78. *Lampsilis virescens* (*Lea*).—MS (Lea)—Bear Cr., Burleson (!)—Little Bear Cr. (!)—Spring Cr., Tus-

cumbia (Call)—Paint Rock R., Paint Rock (!)—Trenton (!) —Hollytree (!)—Princeton (!).

In addition to the above localities, only the following ones are known: Emory R., Harriman, Roane Co., Tenn. (Ortmann, '18 p. 582); Emory R., Wartburg, Morgan Co., Tenn., (collected by myself, Aug. 16, '23); and Coal Cr., Anderson Co., Tenn. (Walker coll.) Thus this species is restricted to the lower and upper Tennessee drainage, and found only in a very limited portion of the latter. It seems to be most abundant in Paint Rock River, judging from the number of specimens at hand. It is not known from the Cumberland.

Its affinities are, on the one hand, with *L. siliquoidea* (*Barn.*) of the Interior Basin (and elsewhere), on the other, with *L. claibornensis* (*Lea*) of the Alabama drainage.

79. *Lampsilis ovata* (*Say*). — MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Paint Rock R., Paint Rock (!)—Princeton (!).

Preferring the larger rivers, and lower parts of tributaries in the lower Tennessee as well as elsewhere. Abundant, under these conditions, in the upper Tennessee, Cumberland, and Ohio drainages, disappearing in a westerly direction. Thus the center of origin cannot be located.

80. *Lampsilis ovata ventricosa* (*Barnes*).—Dixie (!!)—Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Elk R., Fayetteville (!)—Estill Springs (!)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Sequatchie R., Dunlap (Walker coll.)

This has the same relation to the main species as elsewhere, being often associated with it, but going farther upstream (Ortmann, '18 p. 583). It has the same wide distribution as *L. ovata*, and no definite center of radiation can be recognized.

Some specimens of *L. ovata* from the Mussel Shoals ingrade toward *ventricosa;* the only specimen I collected at Dixie inclines toward typical *ovata.*

81. *Lampsilis fasciola* (*Rafinesque*).—MS (!!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!) —Little Bear Cr. (!)—Shoals Cr., Bailey Springs (!!)—

Lawrenceburg (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

Of very general distribution in the Ohio drainage, in the Cumberland, lower and upper Tennessee systems, but somewhat scarce in larger rivers, more abundant in smaller ones. No distinct center of origin can be recognized.

82. *Lampsilis orbiculata* (*Hildreth*).—Dixie (!!) — MS (!)—Decatur (Hinkley)—Limestone Cr., Mooresville (Walker coll.)

A species of large rivers, found in the Interior Basin (Mississippi and Ohio), in the Cumberland (Wilson & Clark, '14 p. 49), and in the Tennessee up to the lower Clinch (Knoxville region, Ortmann, '18 p. 585), where it is very rare. The locality in Limestone Creek is remarkable, for generally this species is missing in small creeks. This distribution indicates, that the center of origin is in the Interior Basin.

83. *Dysnomia* (*Truncillopsis*) *triquetra* (*Rafinesque.*) — MS (!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Flint R., Maysville (!)—Paint Rock R., Paint Rock (!).

Widely distributed in larger and smaller rivers in the Interior drainage, in the Cumberland, lower and upper Tennessee, but nowhere very abundant. Its center of origin is obscure.

(*Dysnomia* (*Truncillopsis*) *arcaeformis* (*Lea.*)—As to the presence of this species in the "Tennessee in Alabama," see: Ortmann, '18 p. 586: It originally comes from the Cumberland River. It has been procured there by others (Wilson & Clark, '14 p. 46), but is rare. It is more abundant in the Knoxville region of the upper Tennessee. It has never been reported from the lower Tennessee. The Carn. Mus. possesses a set, some specimens of which were labeled: "North Alabama," and I have a note, that it is in the Walker collection from the Mussel Shoals. Yet it seems to me to require additional evidence, before we admit this species as a member of the fauna of the lower Tennessee.)

(*) 84. *Dysnomia* (*Truncillopsis*) *brevidens* (*Lea*).—MS (!)—Duck R. (!!)—Lower Elk R. (Conrad, '38).

Reported from the Mussel Shoals by Hinkley, and present from this place in the Walker collection and in Carn. Mus., collected by Smith. Apparently rare in our section, as is seen by the small number of localities known. Also rare in the Cumberland (Wilson & Clark, '14 p. 45), but more abundant in the upper Tennessee (Ortmann, '18 p. 586).

Found nowhere else, and thus a typical member of the Cumberlandian fauna.

(*) 85. *Dysnomia* (*Truncillopsis*) *lenior* (*Lea*).—Duck R., rare.—Paint Rock R., Woodville (Simpson)—Paint Rock (!)—Trenton (!)—Hollytree (!).

A rare Cumberlandian species, found at a few places in the Cumberland, upper and lower Tennessee drainages, in small rivers (Ortmann, '18 p. 587; '24 p. 34). In Paint Rock River it seems to be most abundant, judging from the material at hand.

(*Dysnomia* (*Truncillopsis*) *metastriata* (*Conrad*).—This has been given by Simpson ('14 p. 10) from Woodville, Alabama. This surely is a mistake, for the species belongs to the Alabama drainage.)

86. *Dysnomia* (*Scalenilla*) *sulcata* (*Lea*).—MS (!!).

Very few exact localities are known for this species. From the Cumberland it has been reported (Wilson & Clark, '14) from Halfpone Bar, Cheatham Co., Tenn.; Goodall Island, Smith Co., Tenn., and also Caney Fork, Buffalo Valley, Putnam Co., Tenn. Other exact localities are: Ohio R., Cincinnati, Hamilton Co., O. (Lea); Wabash R., Lafayette, Tippecanoe Co., Ind. It has been credited to the Ohio R. in Illinois (Baker), and Indiana (Call, Daniels), to the Kentucky River ((Rafinesque), but not found there recently by Danglade ('22). Call reports it from a tributary to the Wabash, White River, and Daniels from West Fork White Riv., Marion Co., Ind. From the Wabash drainage it must have crossed over into the lake drainage, where it exists as a variety: *D. sulcata delicata* (*Simpson*). From the Mussel Shoals it has been reported by Hinkley, the Carn. Mus. possesses it (donated by Walker), and I found it myself.

The distribution clearly centers in Ohio and Wabash Riv-

ers, and it is an immigrant both in Cumberland and Tennessee Rivers.

(*) 87. *Dysnomia* (*Scalenilla*) *haysiana* (*Lea*).—*MS* (Hinkley)—Lower Elk R. (Conrad, '37)—Elk R., Fayetteville (Walker coll.)

Apparently rare and local in the lower Tennessee, but more abundant in Cumberland R. (Wilson & Clark, '14 p. 40) and in the upper Tennessee (Ortmann, '18 p. 587). A Cumberlandian type, not found outside of this region.

88. *Dysnomia* (*Pilea*) *personata* (*Say*).—MS (!!).

Reported by Hinkley from the Mussel Shoals, and found there by myself (2 dead shells, male and female). Only two other exact localities are known: Ohio R., Cincinnati, Hamilton Co., O. (Lea), and Wabash R., New Harmony, Posey Co., Ind. (Daniels). In a general way it is mentioned from the Ohio and the Wabash R., in Indiana (Call.)

It seems to be a species centering in the lower Ohio, and is one of the rarest Naiades.

(*) 89. *Dysnomia* (*Pilea*) *biemarginata* (*Lea*).—MS (!) —Elk R., Fayetteville (Walker coll.)—Paint Rock R., Paint Rock (Walker coll.)

The Mussel Shoals are the type-locality for this species, and it seems to be abundant there. Two additional localities are known in the lower Tennessee drainage, and, in addition, it is in the Cumberland and South Fork at Burnside, Pulaski Co., Ky. (Walker coll.), but not mentioned by Wilson & Clark ('14.)

It is a Cumberlandian type found only in the Cumberland and lower Tennessee, absent in the upper Tennessee, but probably the next form (*turgidula*) represents it in the Knoxville region.

(*) 90. *Dysnomia* (*Pilea*) *turgidula* (*Lea*).—MS (Lea) —Duck R., Shelbyville (!!)—Bear Cr., Burleson (!)—Shoals Cr. (Hinkley).

The Mussel Shoals are one of the type-localities of this species. As to its distribution, compare Ortmann ('18 p. 590 and '24 p. 35). From the Cumberland (which is its other type-locality), it has not been recently reported.

A Cumberlandian type, missing in the Interior Basin, but

turning up again in the Ozarks (as *curtisi Friers. & Utterb.*, see: Ortmann & Walker, '22 p. 69 and Ortmann, '24 p. 35, footnote). This is another case indicating a former connection of the Ozark with the Cumberland Plateau.

(*) 91. *Dysnomia* (*Pilea*) *florentina* (*Lea*)—MS (!)—Cypress Cr., Florence (Walker coll.).

Known from the type-locality at the Mussel Shoals, and from Cypress Creek in close vicinity. It has been reported from the Cumberland River (Wilson & Clark, '14 p. 46), and at least "a very inflated female" from Halfpone Bar, Cheatham Co., Tenn., would seem to belong here. Other specimens, chiefly those reported from the upper Tennessee (Ortmann, '18 p. 591) should rather be placed with the next form (*D. florentina walkeri*, see: Ortmann, '24 p. 35).

A Cumberlandian form, probably peculiar to larger rivers, and represented in smaller streams by the next form, and thus not found in the upper Tennessee.

(*) 92. *Dysnomia* (*Pilea*) *florentina walkeri* (*Wilson & Clark*).—Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!).

I have discussed this form, and its relation to *florentina*, in a previous paper ('24 p. 35). It is the form representing the latter in small streams and headwaters, and is found in the upper and lower Tennessee drainage and in tributaries of the Cumberland* but nowhere else, and is a true Cumberlandian type.

(*) 93. *Dysnomia* (*Pilea*) *capsaeformis* (*Lea*).—MS (!)—Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Trenton (!)—Hollytree (!)—Princeton (!).

Apparently as abundant in the lower Tennessee drainage as in the upper, both in larger and smaller streams (Ortmann, '18 p. 593). It is also found in the Cumberland drainage (Wilson & Clark, '14 p. 46.)

* On Sept. 1, '24, I found a male *walkeri* in Cumberland R., Burnside, Pulaski Co., Ky.

It does not exist outside of the Cumberland region, and, on account of its frequency, belongs to the most characteristic Cumberlandian types.

94. *Dysnomia* (*Pilea*) *torulosa* (*Rafinesque*).—MS (!) —Decatur (Hinkley).

Only in the main river, and going up as far as Knoxville (Ortmann, '18 p. 589). Reported from the Mussel Shoals by Conrad and Hinkley. It has never been reported from the Cumberland, but is known from the Ohio drainage, and credited to the Ohio in Illinois (Baker) and Indiana (Call) (Daniels), to the Wabash, Green, and Kentucky Rivers (Rafinesque), and even the Scioto River in Ohio (Lea) (Conrad). But I know only of one exact and reliable locality: Wabash R., New Harmony, Posey Co., Ind. (Daniels.)*

Thus, the home of this species seems to be in the lower Ohio, whence it ascended into the Tennessee, following the main river to the Knoxville region. Above the latter, it changes into the headwaters-form *D. torulosa gubernaculum* (*Reeve*) (see: Ortmann, '18 p. 590.)

(*) 95. *Dysnomia* (*Pilea*) *torulosa propinqua* (*Lea*). — MS (!).

The Mussel Shoals are the type-locality of this form. Besides, it is found in the upper Tennessee in larger rivers in the Knoxville region (Ortmann, '18, p. 589). No other records are at hand, except one given by Baker (Bull. Ill. St. Lab. 7, '06 p. 63) from Ohio R., Illinois, without exact locality. Since this has never been verified, I consider it spurious. This makes this a Cumberlandian type, restricted to the lower and upper Tennessee.

Ball ('22 p. 115) considers *propinqua* a separate species, because it does not intergrade with the other two forms discussed by him (*torulosa* and *gubernaculum*), "in so far as obesity is concerned." Yet his figures for the obesity of

* Ohio R., Cincinnati, Hamilton Co., O., for *cincinnatiensis Lea*, is doubtful, because the status of this form is not settled; and Scioto R., Columbus, Franklin Co., O., probably is incorrect, since the species is not found in so small streams.

propinqua vary from 55 to 62 percent, and for *torulosa* from 51-62 per cent, which is almost identity in this respect.*)

D. propinqua is merely a *torulosa* with the tubercles very poorly or not at all developed, and the two forms actually intergrade in this respect. *D. torulosa gubernaculum* of the upper Tennessee resembles *propinqua* in the absence of tubercles, but is distinctly more compressed.

(*Dysnomia* (*Dysnomia*) *stewardsoni* (*Lea*).—A male of this species in the Carn. Mus. from the Hartman collection is said to be from Florence, Ala. Since this species has never been found in this region by others, and since the locality-records in the Hartman collection are to be used cautiously, it is better to drop this species from the list. It is positively known only from the Knoxville region of the upper Tennessee, chiefly from Holston River (Ortmann, '18 p. 588.)

* The apparent absence of integrades in obesity in Ball's table, p. 114, is undoubtedly due to scarcity of material.

DISCUSSION OF THE NAIAD-FAUNA OF THE LOWER TENNESSEE.

The total number of forms (species and varieties) found in our region is 95; of these 39 are Cumberlandian types (marked in the text by (*)), which is 41 per cent.* But not *all* Cumberlandian forms have been found in the lower Tennessee. The following are missing, according to the list given by me previously ('24 pp. 42-44):

1. *Quadrula cylindrica strigillata* (*Wright*)
2. *Plethobasus cyphyus compertus* (*Frierson*)
3. *Alasmidonta* (*Decurambis*) *raveneliana* (*Lea*)
4. *Micromya trabalis perpurpurea* (*Lea*)
5. *Dysnomia* (*Truncillopsis*) *arcaeformis* (*Lea*)
6. *D.* (*Pilea*) *torulosa gubernaculum* (*Reeve*)
7. *D.* (*Dysnomia*) *stewardsoni* (*Lea*)
8. *D.* (*Dysn.*) *lewisi* (*Walker*)

* As additional Cumberlandian types possibly are to be regarded three others (*Cumberlandia monodonta*, *Ptychobranchus fasciolare*, and *Cyprogenia irrorata*); but I shall disregard these in the following considerations, because they require further study, and because others may fall under the same class.

Five of these (Nos. 1, 2, 3, 4, 6) plainly are merely local forms of the upper Tennessee drainage, possessing representatives in the lower Tennessee, and only three *Dysnomias* (Nos. 5, 7, 8) ar peculiar, well defined types, belonging exclusively to the upper Tennessee, and not at all represented in our region. *D. arcaeformis* and *lewisi* are also known from the Cumberland, while *D. stewardsoni* is very restricted in its range, being known hitherto only from the Knoxville region.

Thus a very large majority of all Cumberlandian shells is found in the lower Tennessee: 39 out of 47 (83 per cent).

On the other hand, we have in the lower Tennessee a number of shells, which immigrated from the lower Ohio (or the Interior Basin in general). According to what has been explained in the text above, this is more or less assured in the following:

1. *Fusconaia ebenus*
2. *Megalonaias gigantea*
3. *Quadrula quadrula*
4. *Quadrula quadrula fragosa*
5. *Quadrula verrucosa*
6. *Quadrula metanevra*
7. *Plethobasus cooperianus*
8. *Pleurobema clava*
9. *Lasmigona complanata*
10. *Anodonta imbecillis*
11. *Anodonta grandis*
12. *Obovaria retusa*
13. *Obovaria subrotunda*
14. *Obovaria subrotunda lens*
15. *Obovaria olivaria*
16. *Actinonaias carinata*
17. *Truncilla truncata*
18. *Truncilla donaciformis*
19. *Plagiola lineolata*
20. *Proptera laevissima*
21. *Lampsillis anodontoides*
22. *Lampsilis anodontoides fallaciosa*
23. *Lampsilis orbiculata*
24. *Dysnomia sulcata*
25. *Dysnomia personata*
26. *Dysnomia torulosa*

These 26 forms make 27 per cent of the fauna. In addition there are 27 others (28 per cent), not mentioned here, in which the center of origin is obscure, they being uniformly present in the Interior Basin and in the Cumberland Region. Some of them will finally prove to belong originally to the Interior Basin, while others may have had their center in the Cumberland Region (if we ever shall be able to find this out.)

This all refers to the *lower Tennessee as a whole.* As

will be seen further below, in the lowermost Tennessee (at Dixie), the Cumberland types are entirely missing.

The above statements lead to the conclusion, *that originally there must have existed a separation of two faunistic types in two different drainage systems, a Cumberlandian River and an Interior Basin River, and that subsequently these two systems became connected, so that their faunas had a chance to mingle.* Of course, the process was not so simple, for the reason, that probably also each one of these two systems had a varied history of its own, during which different parts of their drainages were connected and separated in various ways. This is indicated by the distribution of the different shells, which by no means are uniformly distributed in these old drainage systems.

I should like to emphasize again a fact, indicated already in a previous paper ('24 p. 46). This is, that the *"distribution of the Cumberlandian Naiad fauna is markedly discontinuous"* (at the present time), "being found in the upper Cumberland, the upper Duck, and the Tennessee above the Mussel Shoals, but *not* in the *lower* Cumberland, the *lower* Duck, and probably also the *lower* Tennessee." The latter fact, which was inferred from the conditions observed in the lower Duck River, but not then positively established, has now been *fully demonstrated* by the collections made by myself at Dixie. *Of the 25 forms found here (see below), not a single one belongs to the Cumberlandian types.* The stretch of the Tennessee between the Mussel Shoals and Dixie is unknown, but the lower boundary of the Cumberland fauna must be located in this region.

In order to support this I give here an enumeration of the Naiades which exist at the Mussel Shoals and at Dixie, considering also those which *might* be present.

Fauna of the Mussel Shoals. (*—Cumberlandian; O—Ohioan.)

For the following we possess positive records:

1. *Cumberlandia monodonta*
02. *Fusconaia ebenus*
3. *F. subrotunda*
*4. *F. cuneol. appressa*
*5. *F. edgariana*
*6. *F. barnesiana*
*7. *F. barn. tumescens*
08. *Megalonaias gigantea*

9. *Amblema costata*
10. *Quadrula pustulosa*
011. *Qu. quadrula fragosa*
012. *Qu. verrucosa*
013. *Qu. metanevra*
*14. *Qu. intermedia*
15. *Qu. cylindrica*
16. *Cyclonaias tuberculata*
17. *C. tub. granifera*
18. *Plethobasus cyphyus*
*19. *Lexingtonia dolabelloides*
20. *Pleurobema cordatum*
21. *Pl. cord. plenum*
22. *Pl. cord. catillus*
23. *Pl. cord. pyramidatum*
024. *Pleurobema clava*
*25. *Pleur. ovif. holstonense*
26. *Elliptio crassidens*
27. *E. dilatatus*
28. *Lastena lata*
29. *Lasmigona costata*
30. *Strophitus rugosus*
31. *Ptychobranch. fasciolare*
*32. *Pt. subtentum*
33. *Obliquaria reflexa*
34. *Cyprogenia irrorata*
*35. *Dromus dromas*
036. *Obovaria retusa*
037. *O. olivaria*
*38. *Actinonaias car. gibba*
*39. *Act. pectorosa*
040. *Truncilla truncata*
041. *Tr. donaciformis*
042. *Plagiola lineolata*
43. *Leptodea leptodon*
44. *L. fragilis*
45. *Proptera alata*
*46 *Conradilla caelata*
*47. *Medionidus conradicus*
*48. *Micromya trabalis*
*49. *M. nebulosa*
*50. *M. taeniata*
*51. *M. vanuxemensis*
52. *Ligum. rect. latissima*
053. *Lampsilis anodontoides*
054. *L. anod. fallaciosa*
*55. *L. virescens*
58. *L. ovata*
57. *L. fasciola*
058. *L. orbiculata*
59. *Dysnomia triquetra*
*60. *D. brevidens*
061. *D. sulcata*
*62. *D. haysiana*
063. *D. personata*
*64. *D. biemarginata*
*65. *D. turgidula*
*66. *D. florentina*
*67. *D. capsaeformis*
068. *D. torulosa*
*69. *D. tor. propinqua*

According to their general distribution, the following forms should also be expected here, and probably are present.

070. *Quadrula quadrula*
071. *Plethob. cooperianus*
72. *Alasmidonta marginata*
073. *Obovaria subrotunda*
074. *Proptera laevissima*
75. *Lamps. ov. ventricosa*

Thus, in a fauna of 75 forms, 25, or 33 per cent. are Cumberlandian, and 21, or 28 per cent, are Ohioan.

At Dixie, I have collected the following:

1. *Fusconaia ebenus*
2. *F. subrotunda*
3. *Megalonaias gigantea*
4. *Amblema costata*
5. *Quadrula pustulosa*
6. *Qu. quadr. fragosa*
7. *Qu. verrucosa*
8. *Qu. metanevra*

9. *Cycl. tuberc. granifera*
10. *Plethobas. cooperianus*
11. *Pl. cyphyus*
12. *Pleurobema cordatum*
13. *Pl. cord. plenum*
14. *Elliptio crassidens*
15. *E. dilatatus*
16. *Ptychobr. fasciolare*
17. *Obliquaria reflexa*
18. *Obovaria retusa*
19. *O. olivaria*
20. *Plagiola lineolata*
21. *Proptera alata*
22. *Ligum. rect. latissima*
23. *Lampsilis anodontoides*
24. *L. ov. ventricosa*
25. *L. orbiculata*

This, of course, is not the complete fauna; but according to their general distribution, we should expect also the following shells here.

26. *Cumberl. monodonta*
27. *Quadrula quadrula*
28. *Qu. cylindrica*
29. *Pleurob. cord. catillus*
30. *Pl. cord. pyramidatum*
31. *Pl. clava*
32. *Lastena lata*
33. *Lasmigona costata*
34. *L. complanata*
35. *Alasmod. marginata*
36. *Strophitus rugosus*
37. *Cyprogenia irrorata*
38. *Obovaria subrotunda*
39. *Actinonaias carinata*
40. *Truncilla truncata*
41. *T. donaciformis*
42. *Leptodea leptodon*
43. *L. fragilis*
44. *Proptera laevissima*
45. *Lamps. anod. fallaciosa*
46. *Lamps. ovata*
47. *L. fasciola*
48. *Dysnomia triquetra*
49. *D. sulcata*
50. *D. personata*
51. *D. torulosa*

(I purposely left out the two species of *Anodonta* on account of their erratic distribution, and their general absence from large rivers.)

Although this latter list does not seem to be very reliable, and is largely conjectural, two prominent features are indicated: (1) the comparatively poor character of the fauna at Dixie (51 Naiades against 75 at the Mussel Shoals), and (2) *the total absence of Cumberlandian types. Thus the lowermost Tennessee faunistically belongs to the Interior Basin.* This strongly contrasts with the conditions at the Mussel Shoals, where Cumberlandian elements are well represented.

Farther up in the Tennessee, the elements of the Interior Basin gradually disappear, and in the Tennessee drainage above Walden Gorge, the proportion of Cumberlandian and Interior Basin types is as follows (compare: Ortmann, '18).

The total number of Naiades present is 88. Of these 44

(or 50 per cent) are Cumberlandian, while only 12 (or 14 per cent) belong to those which probably immigrated from the lower Ohio. The rest, 36 per cent, are unknown as to origin. This shows a distinct increase of percentage of Cumberlandian forms (against 41 per cent in the lower Tennessee); on the other hand, the Ohio-types have decreased (from 27 per cent to 14 per cent.)

Very interesting is the comparison of the Knoxville region with the Mussel Shoals. These two localities may very well serve as a basis for judging the mutual relations of their faunas, for they represent similar stretches of the river, equally well studied. According to the list given in my paper ('18 pp. 624, 625) for the *Tennessee River in Knox Co.*, 64 Naiades are known from these parts. Of these, 28 (or 44 per cent) are Cumberlandian, 8 (or 13 per cent are Ohioan, and the rest (43 per cent) is of unknown origin, while at the Mussel Shoals these percentages, as we have seen, are: 33 per cent, 28 per cent (and 39 per cent.)

This all serves to support the conclusion that, considering the whole Tennessee drainage, *we have, in the lowermost parts (Dixie), a rather pure Ohio (or Interior Basin) fauna; in the region of the Mussel Shoals (probably somewhat below), Cumberlandian types begin to appear; farther up, the latter become more and more prevalent, and the Ohio types gradually disappear,* but nevertheless they constitute a certain percentage of the fauna at least as far as the Knoxville region. This decrease of Ohio elements continues farther up from Knoxville. *On the other hand, the percentage of the Cumberlandian forms correspondingly increases from the lower to the upper Tennessee,* which, however, is not so much due to an increase of the number of these types, but is largely brought about by the decrease alone of that other element.

We do not need to go into details with regard to the headwaters of the Tennessee: but I should like to mention, that in the lower parts of Holston and Clinch Rivers a few Ohio-types are still present, but they soon disappear. Also the types of unknown origin become gradually fewer in the upstreams direction, while, on the other hand and in conse-

quence of this, the Cumberlandian forms increase in percentage (less so in absolute numbers); at some of the well worked headwaters stations in Holston, Clinch and Powell Rivers, their percentage goes up to 75 per cent and even higher.

It is also not necessary to consider more in detail those forms, which, on account of their wide and general distribution, we have classified as of doubtful origin. Yet attention should be directed to the probability, that just among them we may have Cumberlandian types, which *descended* the Tennessee River (and also the Cumberland), and invaded the Ohio and the Interior Basin. In a few cases, we have evidence to this effect; but in most of them, the details of their distribution *in the Interior Basin* must be studied more closely, before we shall be able to draw any conclusions.

APPENDIX.

Note Concerning Unio cor Conrad.

Frierson's figure of the Type of *U. cor* (Naut. 29. '16 pl. 3 f. 1-3) is either *Fusconaia edgariana* (*Lea*) or *F. cuneolus appressa* (*Lea*), and, as I believe, probably the latter, but this cannot be made out from the figure alone, which does not show color and texture of epidermis. In shape, it absolutely resembles a typical *appressa*, a form which I did find at one of Conrad's type-localities for *cor*, in Flint Creek, (see above p. 329). Pilsbry (in: Ortmann & Walker, '22 p. 7) says that *cor* resembles *appressa* in the epidermis, but that it differs from either, *edgariana* and *appressa*. But the difference given do not hold good: the posterior ridge varies in sharpness, and so does obesity. According to Ortmann ('20 p. 284, 285), the diameter ranges, in *appressa*, from 51 to 66 per cent; Frierson's figure has 68 per cent; and my specimen from Flint: 57 per cent. Thus from the study of the type specimen, *cor* rather seems to be *appressa*.

But this would not have any influence upon nomenclature: the original *cor* is not sufficiently characterized so as to make out, whether it is *edgariana* or *appressa*, and even Frierson's redescription and figure leave the question undecided. Thus Lea's name stands. There is hardly any probability, that there exists, in this region, a *third* form (*cor*), different from either *edgariana* and *appressa*.

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THE PRESENT STATUS OF THE RUFFED GROUSE IN PENNSYLVANIA.

BY

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The richly colored woods of autumn would seem strangely silent without a familiar whirr of wings and a glimpse of that magnificent broad-tailed bird so dear to the hearts of every sportsman; and lifeless would seem the mildest days of May, even with the music of vireos, tanagers, and thrushes all about us, were we not occasionally to hear the distant throbbing of grouse wings sounding the summons to new life and Spring. Wherever he is found the Ruffed Grouse is a favorite; not alone to the sportsman, for his cunning ways and the disconcerting uproar of his flight, but to every man who has ever known the woods, for his beauty and character.

Unpleasant as it is to face such a situation, our Pennsylvania Ruffed Grouse (*Bonasa umbellus umbellus*) are in danger of extermination. Letters and verbal reports have come into the Game Commission offices, not only from all parts of the State, but from points throughout the entire range of the bird, indicating in many regions an almost unprecedented scarcity of this game bird. It should be understood that the scarcity of grouse is not alone restricted to Pennsylvania; but the present paper will consider only the local situation. In many regions where even so recently as during the 1923 hunting season dozens or hundreds of birds were seen, our game protectors have found but four or five birds. Some of the more fortunate sportsmen have found larger numbers of birds far back in the wilds, associated

in large flocks, and there is a report abroad that all the birds have merely pushed farther than usual into the ridges, and this is doubtless to an extent and locally true. But any man who has walked for days through typical grouse country where the birds had been known to occur abundantly, without seeing more than four or five birds; any man who has viewed the past season's kill (1924), with its pitiably small proportion of young birds; any man who has heard the direct words of hunters in almost all portions of the State, bewailing a loss of grouse—anyone who has faced these facts personally, as I have, cannot doubt a wide-spread and alarming decrease in the grouse population. The situation is serious in some sections, and the mere fact that certain regions are still favored with the usual supply of birds does not make the general problem less important. The sportsman who thinks that the birds are as abundant as usual because he has seen them far back on the ridges, where he is not accustomed to hunt them, concludes that all the birds have moved back to the wilder areas. He forgets that these wilder areas are usually not investigated at all, and therefore supposes that all birds have moved thence, without taking into consideration the normal grouse population of these very areas.

Naturally, many interested sportsmen and nature-lovers have sought an explanation of this decrease in the grouse population, and as an interested student it is thought wise to give the result of our inquiries into the situation. It is safe to state that the sportsmen themselves have not been responsible to any greater extent than usual for this decrease, although it will be admitted that they have had their part in thinning out the grouse population. Most sportsmen realize that if they kill one bird in a hundred, only ninety-nine are left; game population is as subject to arithmetical laws as is any other thing. For the most part our sportsmen have shown themselves to be keenly interested in the welfare of the birds and in many sections have refused to kill them when they noted their scarcity. It has been very gratifying to note this, because it indicates that the real sportsman of today honestly cares more for the live birds than he does

for dead ones—a thing that many a member of the Audubon Society might not admit! Of course there are, and regrettably always will be, those "hogs" who would gluttonously kill the last individual of any species of bird, but it was noticeable in a recent tour of the hunting camps of the State that the sportsmen had a genuine personal interest in the grouse. The letters which come to the offices of the Game Commission also indicate the most enthusiastic interest in their immediate protection.

The greatest cause for the decrease of grouse seems to have been the lateness, chillness, and irregularity of the rearing season. Evidence is at hand that in some sections nests were actually flooded when placed in low situations. Examination of sets of eggs has disclosed the fact that numbers of nests were deserted when the embryos in the eggs were only half or three-fourths developed. In some cases even second layings of the birds were deserted, due, presumably, to their chilling. One game protector who had under his observation at one time six nests, reports that four were deserted. If a similar proportion of nests throughout the State were thus abandoned, the diminution of the local population of the birds is easily understood. This chill weather affected not only the eggs in the nest, but doubtless also took away a great many young birds just hatched, since they are at that stage of development, of a delicate constitution, and cold, wet periods of long duration may have killed even half-grown birds. Incidentally, this cold season has been a menace also to Bobwhites, Ring-necked Pheasants and Wild Turkeys—notably the last named species.

As a direct result of the cold spring, insect-life was not as abundant as usual. During the comparatively short period of normal grouse-egg hatching, when the young birds demand certain particular foods, these foods were scarce. Ants' eggs, for instance, are an important food of the downy chicks, and observers in several regions agree that such food as this was either almost wanting or unavailable. Nymph grasshoppers were not as abundant as usual, and many cater-

pillars which feed commonly on low vegetation and which the young grouse capture, were rare. Young birds which might successfully have weathered the cold season with sufficient food, could not do so in an under-nourished state. And many young birds which might have weathered the cold season even in a half-starved state, certainly fell easy prey to vermin as a result of their weakness.

Due to the recent report of some disease in certain sections of the bird's range, many observers have naturally laid the decrease in the Pennsylvania birds to this factor. Examination of the bodies of local specimens so far shows however, that if any disease occurs in Pennsylvania grouse, it is not the scourge generally known as *grouse disease*. Futhermore, there is little evidence otherwise that our birds have suffered from disease. Not one of the many observers and game protectors queried has spoken of finding dead birds in emaciated condition or live birds in a drowsy stupor which would indicate ill health, and all birds observed this season were obviously in exceptionally fine condition. Examination of specimens which have come into my own hands has proved that the birds which remain are in very good health. Their bodies were sturdy and fat and their digestive systems in excellent normal condition. And whatever may be the reason for the bird's decrease, food conditions during the past fall are certainly not to blame, because if ever there was an abundance of various favorite foods such as berries, beechnuts, wild grapes, mast and browse, there was an abundance of such food at that time.

Predatory animals, of course, have been responsible to the usual degree in decimating the grouse population. Reports of the Game Commission force indicate, however, that very few instances of killed-grouse remains have come to their attention. It is well known to all naturalists that any carnivorous mammal or bird, after killing a grouse, usually pulls out some of the large wing or tail feathers which are left as an indication of their feast, so that were vermin a very serious menace, such remains would most certainly be found. Of the mammals which prey on grouse, undoubtedly

Bay Lynxes and Gray and Red Foxes have been the most serious offenders, and these animals have been more than usually abundant in some sections. Great Horned Owls and Goshawks have not however, been abundant and are certainly not to blame. Skunks probably caused some damage particularly during the nesting season, and Raccoons, Weasels, Opossums, Red Squirrels and stray house-cats took their usual toll. All in all, however, it seems only fair to lay chief blame on the cold nesting and early rearing season, which has been, as all observers will agree, unusually severe.

Even in facing this discouraging situation, there is a compensation in that although we have comparatively very few birds, all that ar eleft are in exceptionally fine condition, being for the most part fully grown birds whose hardiness is principally responsible for their present existence. This means that with a favorable nesting season this spring, the young grouse will be exceptionally sturdy ones, and we have no reason to be disheartened provided that the greatest possible protection is given the birds. Bird-lovers should make certain that grouse in their region are well provided with food and cover. Wandering house-cats should, by all means, be killed. These vermin are always a menace and are not beautiful or interesting as some of our native predatory mammals are.

A State-wide closed hunting season on grouse is to be strongly recommended; this will give the birds two undisturbed nesting seasons. It is most gratifying to find that all far-seeing sportsmen in the State are heartily in favor of such a closed season. Some objectors to such a closed season are to be heard, of course; and we all understand the attitude of the man who happens to have seen an unusually large number of birds during the past season, and who feels that no closed season is necessary. But the sportsman who kills game birds realizing their rarity, or who refuses to support his State's laws to the best of his ability, even though his own personal liberties are somewhat curbed, is of course, defeating his own best interests. The man who knows the grouse needs a closed season, and still clamors for his an-

nual kill is just a "hog"—that's all, and not a real sportsman.

Whatever legislation may be enacted, however, may we not fairly expect our enlightened sportsmen, ornithologists, and lovers of the out-doors to combine in an effort to bring these splendid birds back to their former abundance? Never, I believe, will the men of this Commonwealth permit this magnificent bird to join the phantom ranks of the Passenger Pigeon, Labrador Duck, and Eskimo Curlew.

A FEW SPRINGTIME FLOWERS.

By Mary Hovey.

Hepatica, Hepatica, Hepatica or (Hepatica, triloba) of Gray is really our first spring flower, although I have known anemone and spring beauty to come at this time. Hepatica's last year's leaves stay on all winter and show us where to look for our earliest blossoms. On the lake shore, where the icy winds blow from off the northern waters, these dainty blossoms grow in sheltered ravines. Farther west the flowers may be found in gently sloping patches of woods with trees for their protection. Looking among the dead leaves on a late March day one may find, close to the trees, little fuzzy balls, just starting to uncurl. In three or four days or a week, according to the weather, there will be representations of tiny rosebuds, then a few days of warm sunshine and here are lilac, pink, or white sepals, though they look like petals, forming the blossom.

Bloodroot, Indian Paint, Red Puccoon, (Sanguinania Canadens) a neighbor grows beside trees as does the hepatica. It may be found in small patches among the sere leaves. Its name suggests a color which a bird that comes about this time, the ruby crowneed kinglet, wears. But the plant shows a deeper shade in its roots when they are broken off.

Go to the woods to see spring beauty or Claytonia, (Claytonia Virginica), in all its loveliness. If picked it wilts right away but the great patches of tiny pink flowers make an unforgetable sight, wee ground apple blossoms before the trees are in bloom.

Rue-Anemone, (Syndesnon thalictroides) — Thalictrum enemonoides, of Gray—is more common than the true enemonie (Anemone quinquefolia). The name is taken from the Greek story of Venus and her lost lover Adonis. According to fable this little flower tells of the wind's coming in the first days of spring and Pliny said that the breezes unfolded its blossoms.

In the swamps we find buttercups and also in the meadows. (Ranunculus acris) or common meadow buttercup, is the one most of us know though there are numerous other kinds. I have spent many days among them and wished some kindly naturalist would come from the prairie and help me to become acquainted with the different species. One of my earliest memories was a field of these blossoms and violets mingling with the warm spring sunshine, and the joy of being a child, alive and free to roam on a wondrous awakening day.

Shooting star, American cowslip, Pride of Ohio, (Dodecatheon Meadia), is a western flower growing tall beneath trees and in meadows. My childhood's days were spent on the lake shore so I did not encounter this blossom until we moved to a suburb west of the city. Then I found the star like flowers pointing upward.

Wild or spotted geranium, Crane's-Bill or Alum-root, (Geranium maculatum), brings back early memories. These blossoms, lifting up above their wealth of leaves look like a crane standing on one foot.

Then comes the wild blue phlox, (Phlox divanicata), a sea of turquois in the woods. It is chilldhood's memory of beauty, a contrast to winter's bare branches at a time when the trees are just beginning to be green.

Violets (Viola), a welcome to our best beloved springtime flower. Who does not know the common meadow violet and who does not love it? Many there are who ignore all the rest in Nature's wild garden but they would be ashamed to overlook the violet. From the movie fan to the lyrical singer, all greet this little flower. It connects the blossoming world with humanity. If man is willing, it directs and guides him to rarer flowers and thus creates a desire to know more about life's beauties.

The violet is to the flower world what the robin is in the bird world or the swallow-tail butterfly in that realm. Ever wellcome, suggestions of hope and joy, and of cheer.

So bloom best known, best beloved flower, and unite humanity with universal beauty for without you our world of blossoms would be void.

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